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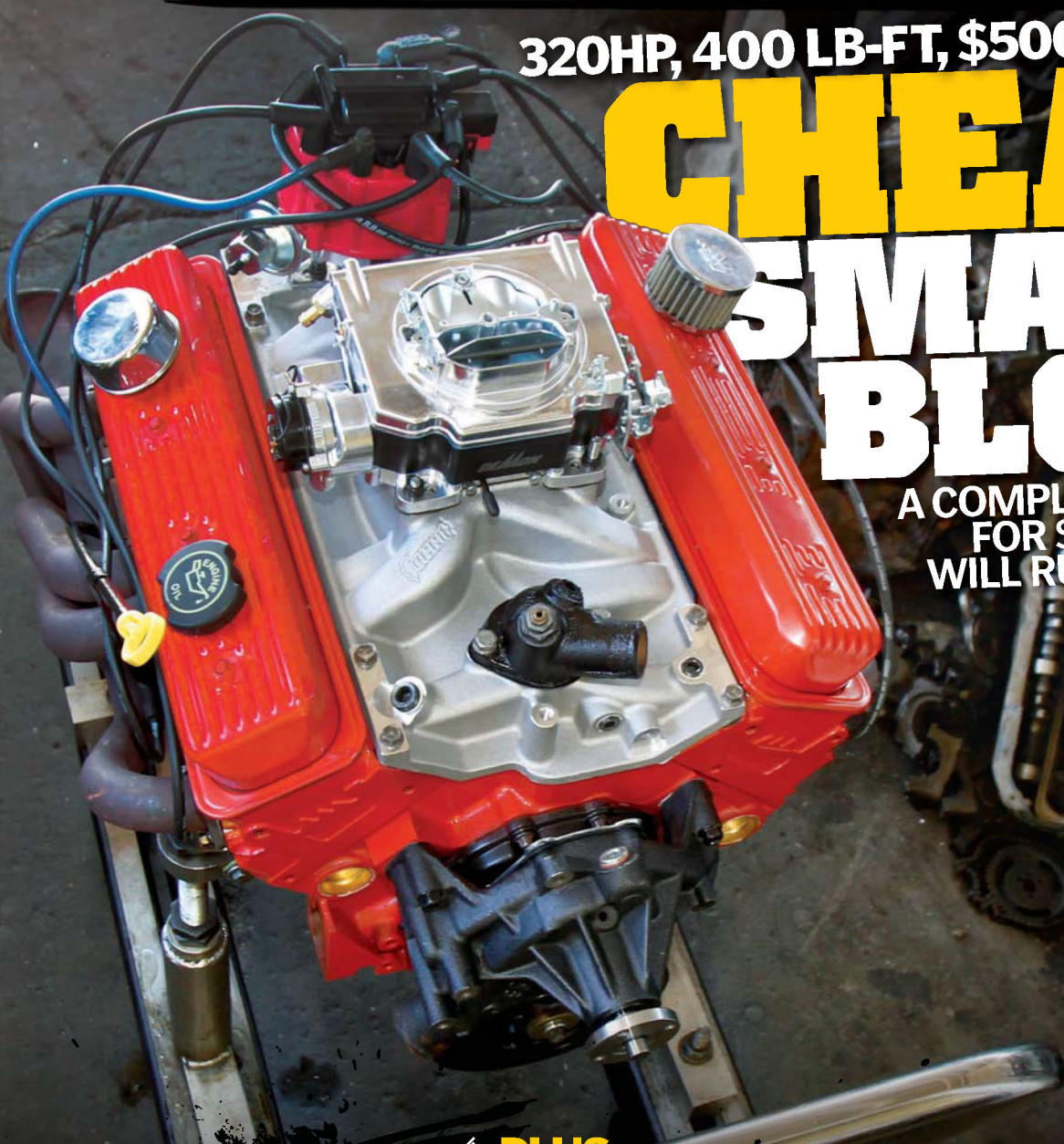
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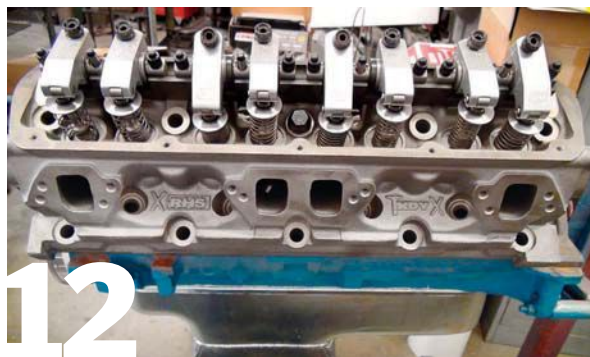
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Low-buck Chevys in Indio, CA. Photo by John McGann.



SHOP TALK



Wisconsin Today anchor Charles Benson, me, Dr. Ford (Jim Plimpton), and Scotty K after my spot on the news.

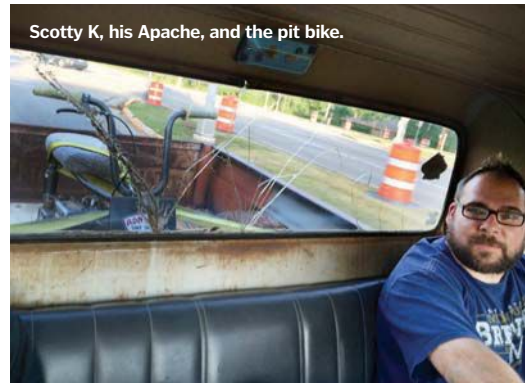
WITHOUT FRIENDS LIKE THESE...

No peyoratives here, without friends like these, I couldn't get my job done—no way, no how. In my travels across the country, I've met some of the coolest people—dudes who will drop everything to help you with a problem or just to grab dinner and show you around their hometown. In June, I was humbled by the generous hospitality of a couple in particular during a trip to Milwaukee to promote the **Car Craft** Summer Nationals that took place at its new home at the Wisconsin State Fair Park July 17-19.

Scotty Kasabuske drove me all around Milwaukee in his 1960 Chevrolet Apache, showing me local hangouts, fast cars, and the builders of said fast cars. His Apache is a hilarious combination of thrashed and cool, and he keeps a pit bike in the bed, "in case the truck breaks down." I met him at last year's King Of The Streets no-prep race at Great Lakes Dragaway in Union Grove, Wisconsin. He was driving "The Grinch," an equally hilarious, ratty-looking, Fox-body Mustang that nearly won its class. He found an ultra-cheap T56

transmission for my 1967 C10, and I hope to be cruising in double overdrive by the end of the year.

Jim Plimpton is known as Dr. Ford in the radial racing world. His son, Jimmy, drives a Ford Fairmont they built together to compete in X275 races around the country. Aside from the fact that it's a Fairmont, it's unique in that a big-block Ford, not a Chevy, is under the hood. When TMJ4, the local NBC affiliate asked that I bring a car to my interview, I immediately thought of Jim, who owns Authentic Auto, an autobody repair and restoration shop in



Scotty K, his Apache, and the pit bike.

Milwaukee. Without hesitation, he said he'd be at the TV station with some sort of cool car, and what he brought turned out to be a beautiful 1957 Chevy that belonged to one of his customers (Jim had permission from the owner, of course). It was perfect for the spot on the news, and even better, it was a car-crafty build, too: 572 big-block with a Doug Nash five-speed. Jim even drove it to the studio and back in the rain.

Finally, I have to thank my buddy, Fabian, from the Brotherhood of Street Racers. For years, he's guided me like a Sherpa through the street-racing world of Southern California. Recently, he dropped by the warehouse while I was pushing to get my C10 running. Without hesitation, he grabbed some tools and got busy helping wire up the ignition system. The truck runs great, now, and you can read why next month, so thanks to everyone for your help.

—John McGann

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Fabian making connections while I do something under the truck.





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GM LS Gen IV Tach Driver - Catalog Page 63

The ECM used in GM Gen IV applications does not have a tach output wire to provide a tach signal to a tachometer. This small device converts the 5 Volt 58X crank sensor signal from any Gen IV GM V8 engine into a 12 Volt signal useable by most aftermarket and OEM tachometers. **60150**



GM LS Coil Extension Harnesses - Catalog Page 63

Clean up your LS installation by moving the coil sets off the valve covers. Includes two pigtails to relocate coils. Factory color coded wires and weatherproof connectors. One drivers side, one passenger side pigtail. **60128 - 36" 60129 - 48" 60127 - 24"**

Clean Up Your LS Installation



Universal Fuel Pump Relay Kit - Catalog Page 77

A relay will prevent voltage drops at the fuel pump thus maintaining constant fuel pump pressure, and will prevent fuel pump amperage from damaging the electrical system. It's a good idea to relay your fuel pump for the street and a must when you're racing. **50102**

Hot Shot Amperage Booster - Catalog Page 77

Designed to overcome starting problems due to an over-heated GM style starter or worn out electrical system. Works by boosting amperage to the starter solenoid. **30202**

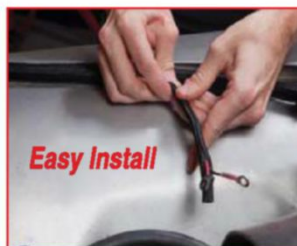
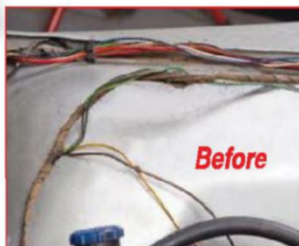
Maximum Starting Power



Exclusive - Power Braid & Classic Braid Wire Wrap Kits - Catalog Page 73

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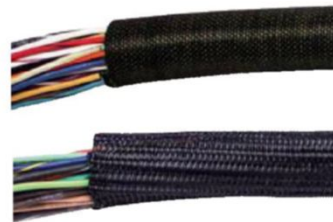
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FUEL SYSTEM

The hungry 676ci powerplant is fed copious amounts of VP Racing Fuels Q16 racing gasoline through a simple but high-volume system. A Waterman mechanical fuel pump is fastened to the camshaft, so volume is dictated by engine rpm. The fuel is sucked from a front-mounted cell with AN20 lines and sent to the fuel rails via AN12-sized lines, which feed massive Moran Motorsports 325-lb/hr fuel injectors.



TOP END

The top half of the engine has to move a lot of air from the Precision turbochargers. Pro Line Racing worked with mountain motor specialist Sonny's Automotive to produce proprietary billet-aluminum, symmetrical-port cylinder heads that are specific for turbocharged applications such as this one. The camshaft is custom-machined from billet, and it actuates a complete Jesel valvetrain. Air is funneled into the cylinder heads via a custom intake that Pro Line Racing also fabricates from billet.

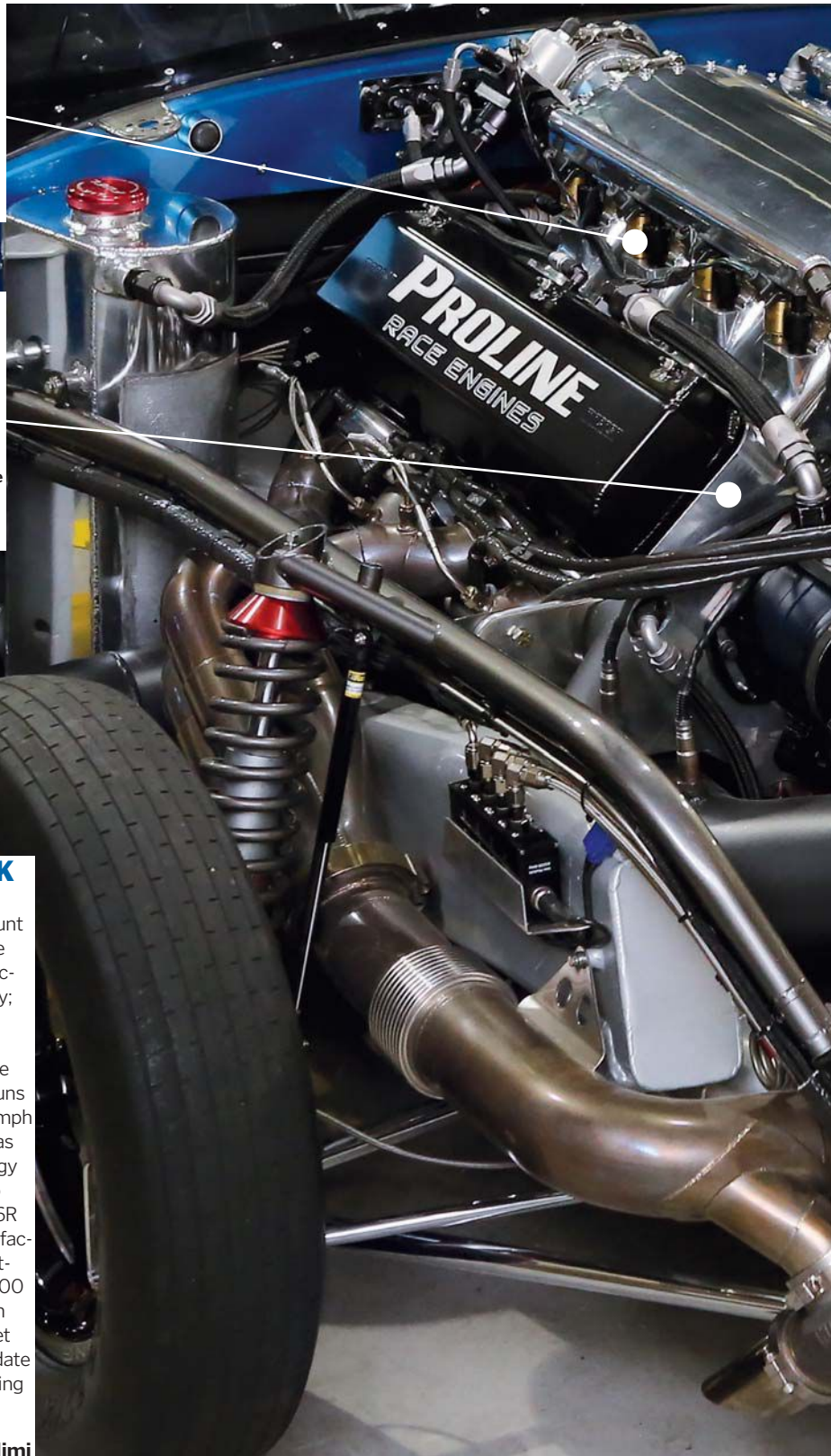


4,000HP, 676CI BIG-BLOCK

Rodney Massengale / Anderson, IN

It is a game that requires an obscene amount of horsepower—DOT-legal, radial-tire-style drag racing—and it's sweeping across sanctioned and outlaw races across the country; RPM Transmission's Rodney Massengale comes to battle with a proven twin-turbo package from Pro Line Racing. The massive engine powers a 2010 Corvette ZR1 that runs bottom fours at speeds of more than 190 mph in eighth-mile competition. The chassis was built by K&K Advanced Door Car Technology and sports a double-framerail, SFI 25.3 Pro Mod-style chassis under a carbon-fiber C6R body—complete with a stock firewall and factory front framerails with a stock(ish) front-suspension system. The race weight is 3,200 pounds, while the four-link rear suspension plants a pair of Mickey Thompson ET Street Radial tires (315/60-15). The best time to date is a 4.25 at 193 mph, and the team is gunning for the 3-second zone in 2015.

By Mike Galimi / Photos: Mike Galimi





DIGITAL CONTROLS

The engine-management system is a Big-Stuff3 EFI, and it handles more than just ignition timing and fuel delivery: it acts as a data logger, traction control, and boost controller. As if those weren't enough controls, Massengale runs a MSD Power Grid with ARC module and an MSD 8-Plus ignition box to light off the mixture of fuel and compressed air. This year the team has added a Davis Technologies Profiler traction control.



LONG-BLOCK

Some call the engine a Chevy while others have actually tried to claim it as a Ford, but truth be told, the engine is technically a custom big-block with a 5.00-inch-bore spacing. It shares nothing with either manufacturer's traditional big-block engines. The foundation is a billet block that is manufactured by CN Blocks. Filling it is the job of a Sonny Bryant 4.875-inch stroker crank. Bill Miller aluminum connecting rods connect the Diamond pistons (4.700-inch bore) to the crankshaft, while a Moroso dry-sump oiling system keeps it all lubricated.

BOOSTED SPECS

Custom headers and charge piping are the order of the day because there aren't any mail-order, turbo-system parts for 4,000hp combinations; credit K&K Advanced Door Car Technology for the fabrication work. The headers are made from stainless steel, while the turbo piping is aluminum and powder-coated black. A pair of Precision Pro Mod 98mm turbochargers provide the boost. Two TIAL wastegates are charged with controlling the pressure levels and are commanded by the BigStuff3 engine-management system. A massive in-car, air-to-water intercooler chills the 48 psi of boost before it enters the big-block engine.

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POWER PORTING

How to Make 600 HP with Cast-Iron Heads on a Mopar 340 Stroker

By John McGann / Photos: John McGann and Brian Haflinger

➔ There's a pretty simple answer to making horsepower, no matter what engine you're working with: airflow. Air needs to enter the cylinders as efficiently as possible, and exhaust needs to exit just as quickly. Things get complicated from there, however, because that's when you need to decide on things like compression ratio, cam specs, and timing. Other factors to consider include transmission ratios and rear-axle ratio—variables that affect how effective your engine is at getting power to the ground, but those are for

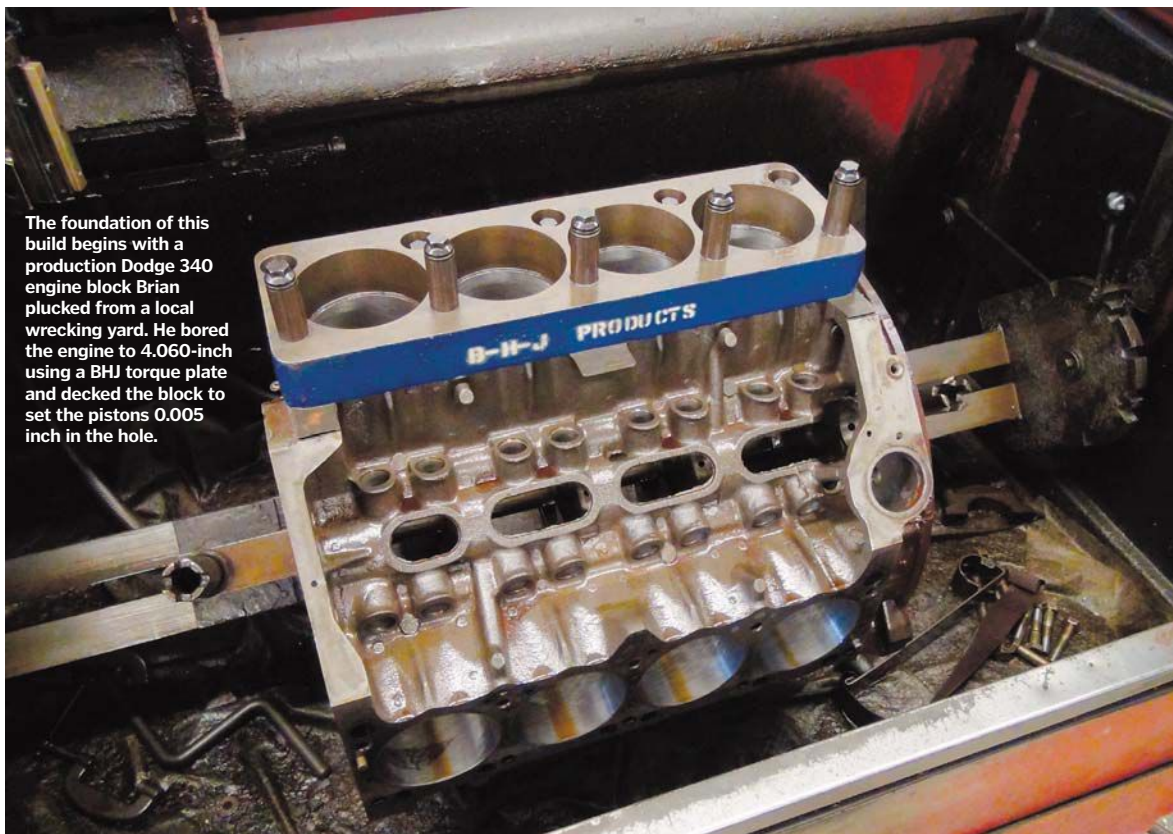
later articles. Here, we are showing one specific way to get maximum horsepower from modest displacement and a set of cast-iron cylinder heads.

IMM Engine and Dyno is a small, father-and-son shop in Indio, California. Brian Haflinger bought the business from his father, Fred, about 12 years ago, and the two have been churning out some impressive engines through the years, all while continuing to work on everything from flathead Fords to old tractor engines. Brian has a reputation as a specialist of the small-block Mopar engines for a while. It's a natural

fit; he owns a 10-second 1971 Duster. This build is an evolution of one **Car Craft** ran in the June 2010 issue that made 480 hp with a set of these cast-iron cylinder heads, installed right out of the box. Ever since then, Brian has been curious about just how much horsepower can be made with these castings, which are now manufactured by Indy. He experimented with some porting and had his best-flowing version scanned and turned into a CNC program, which was used to port this set of heads here. Let's check out what goes into a 600hp, small-block Mopar.



The foundation of this build begins with a production Dodge 340 engine block Brian plucked from a local wrecking yard. He bored the engine to 4.060-inch using a BHJ torque plate and decked the block to set the pistons 0.005 inch in the hole.



Brian selected a 3.79-inch-stroke crankshaft from Molnar Technologies. Forged from 4340-alloy steel, it is reasonably priced and will take lots of abuse in the form of high rpm and maybe a hit if nitrous if Brian is so inclined. Brian chose this stroke length because it will put the engine at the rpm he wants to run through the lights at the track. Note how this small-block easily swallows nearly a 4.00-inch-stroke crankshaft without any grinding for clearance.



The crank is paired with a set of Molnar's steel 6.20-inch H-beam connecting rods. These are actually small-block Chevy rods (gasp!) with a 0.927-inch pin diameter and a 2.100-inch crank journal. The rod bearing clearance was 0.0027 inch.

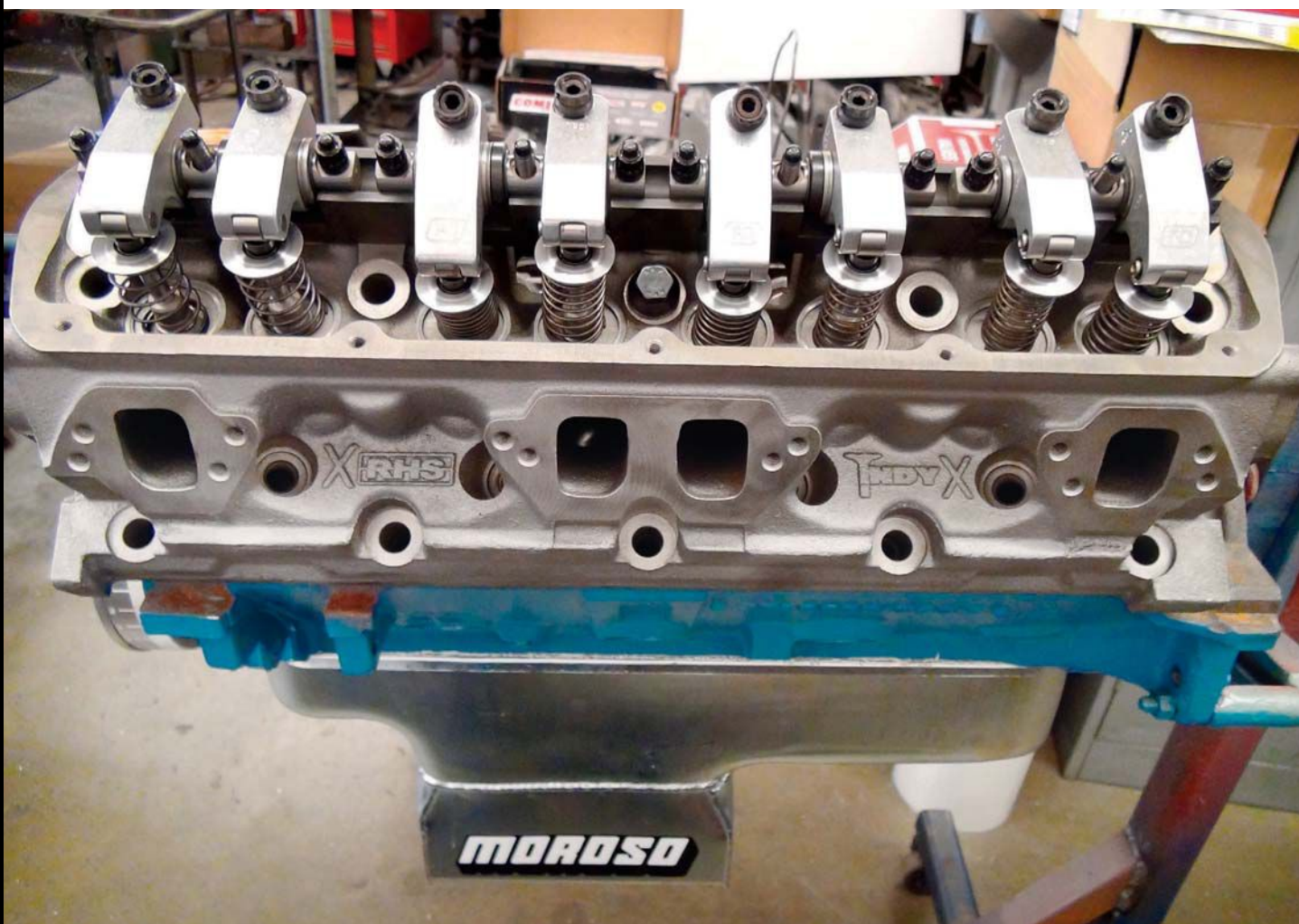


Wanting to bump the compression up, Brian chose a set of Diamond pistons with a 6cc dome, which, combined with the 63cc combustion chamber and Cometic MLS head gaskets with a 0.040-inch compressed thickness, yielded a compression ratio of 13.00:1. Get the race gas ready! Note the extra material above the top ring land. This allows for a deeper valve relief on the domed piston. Brian measured 0.125-inch piston-to-valve clearance on the intake side and 0.1200-inch on the exhaust. The piston-to-wall clearance is 0.005 inch. The rings are from Hastings and include a 1.5mm, moly-faced, ductile iron top ring, a 1.5mm Napier second ring, and 3.0mm oil control rings. Brian gapped the top rings to 0.020 inch and the second rings to 0.044 inch, which allows any pressure that builds in the space between the top and second ring to escape more easily, making the top ring seal better.



As is his standard practice, Brian opened up and smoothed the oil passages in the block leading from the pump to the oil galleries and did the same to the outlet passage on the oil pump.

Assembly of the short-block was completed with the installation of a Melling high-volume oil pump. ARP main and rod bolts were used to secure the rotating assembly.



One way to make big horsepower numbers is through lots of rpm, but to do that, you need to build a stable valvetrain; in this case, $\frac{7}{16}$ -inch valve stems, lightweight valves, titanium retainers, and pushrods and rocker arms that don't flex or bend under the relatively high spring rates needed to control the valves at 7,000-plus rpm. Brian chose these paired-assembly T&D shaft-mount

rocker arms because they fit the criteria. Seen here with checking springs installed, the T&D rocker arms offer a 1.7:1 ratio on the intake and 1.6:1 on the exhaust (1.6:1 is stock) and oil through the pushrods, like the later Magnum-style cylinder heads. The Manton pushrods measure $\frac{1}{32}$ -inch with a 0.140-inch wall thickness.

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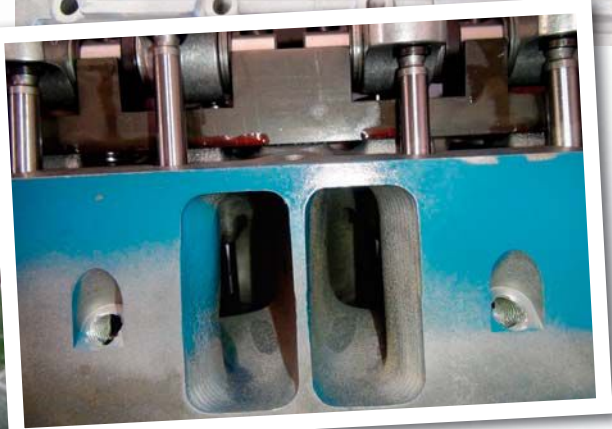
The Comp solid roller cam offers 267/272 degrees duration at 0.050-inch tappet lift, 0.685/0.650 gross valve lift, ground on a 107-degree lobe-separation angle. Brian had to bush the lifter bores because the high lift numbers pushed the lifters high enough to uncover the oil grooves, which cause a major internal oil leak. That's a pushrod-checking tool being used here, which allows Brian to measure the exact length pushrods he will need to get the rocker arm to contact the tip of the valve correctly.



Running the engine through a full cycle, Brian checked the rocker arm's sweep across the tip of the valve to ensure it was centered over the valve. Note the use of ARP fasteners on the valvetrain components.



Having established the correct pushrod length, Brian assembled the heads with IMM/Ferrea 6,000-series valves (2.02-inch intake, 1.60-inch exhaust) and IMM's solid-roller cam spring kit, which measures 210 pounds on the seat and 525 pounds of open pressure.



You can see the effectiveness of porting these heads, which are limited on the intake side by the protrusion of the pushrod passage into the intake runner. The porting opens up this area as much as is effective to maximize airflow through the port, paying close attention to the port's cross-sectional area and a complete flow curve. The intake runners measure 200 cc.

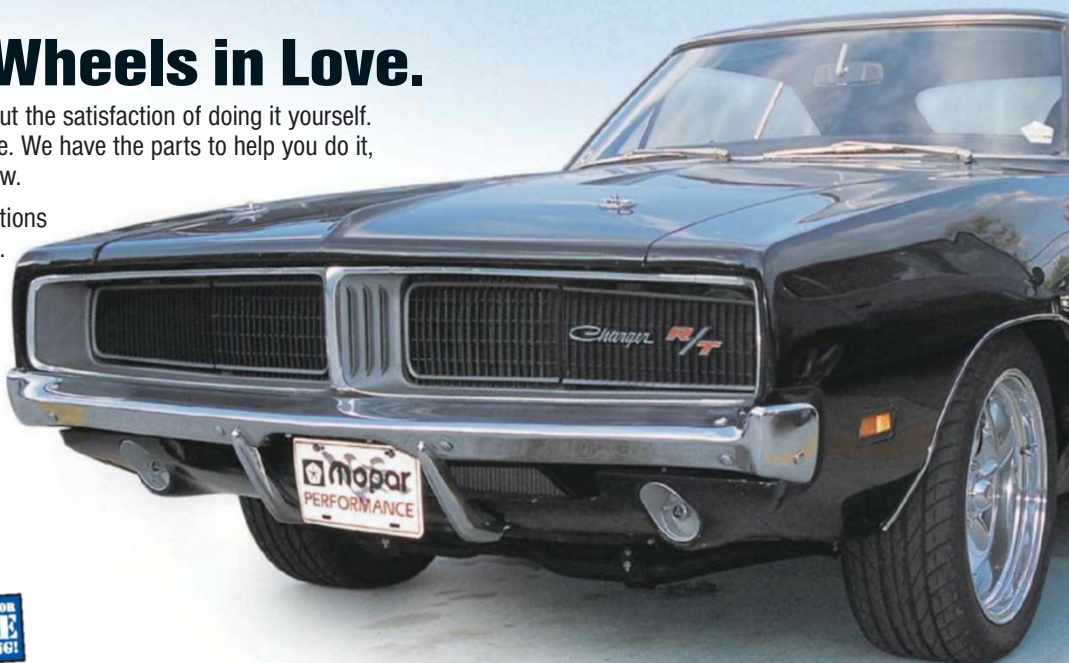


Nearing completion, the Innovators West dampener and Indy's single-plane intake manifold were installed. The manifold is a good fit for the engine speeds and power curve we want the engine to generate.

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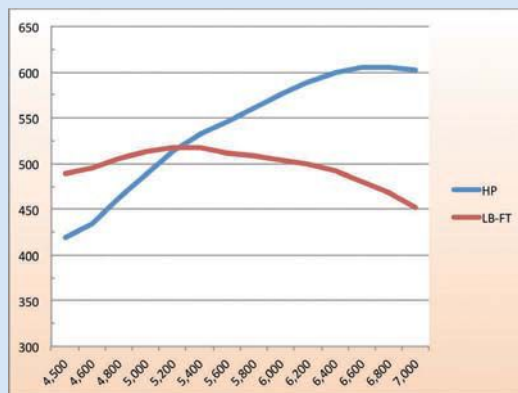
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ON THE DYNO

On IMM's DTS engine dyno, the engine made its best power with a Holley 1000 HP carb, the valves set to 0.018-inch lash, an MSD billet distributor, MSD's Digital 6 ignition box, and MSD's HVC II coil. The timing was set to 32 degrees total timing, and the TTi headers had 1 $\frac{7}{8}$ primary tubes with 3-inch collectors. These are the same headers that will be used when this engine is installed in a car. For all pulls, the oil temperature was 160 degrees and the water temperature was 140 degrees. The engine ran on VP Racing 110-octane unleaded gasoline. The first couple of pulls were disappointing, with power levels at just 574 hp, but advancing the timing just 2 degrees yielded nearly a 20hp increase to 593. Tightening the lash unleashed a few more ponies, and the engine ultimately made 606 hp at 6,800 rpm. The engine made more than 600 hp from 6,400-7,000 rpm and Brian carried the dyno pulls to 7,300 rpm, about where his car would run through the traps at the dragstrip. 🏁

RPM	HP	LB-FT
4,500	419	489
4,600	434	495
4,800	462	506
5,000	488	513
5,200	513	518
5,400	532	517
5,600	546	512
5,800	561	508
6,000	576	504
6,200	589	499
6,400	600	492
6,600	606	481
6,800	606	468
7,000	602	452



→SOURCES

ARP; 800/826-3045; ARP-Bolts.com
Comp Cams; 901/795-2400; CompCams.com
Diamond Pistons; 877/552-2112; DiamondRacing.net
Holley; 270/782-2900; Holley.com
IMM Engine & Dyno; 760/347-5493; IMMEngines.com
Innovators West; 785/825-6166; InnovatorsWest.com

Manton; 951/245-6565; MantonPushrods.com
Molnar Technologies; 616/940-4640; MolnarTechnologies.com
Moroso; 203/453-6571; Moroso.com
MSD Performance; 915/857-5200; MSDPerformance.com
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HALF A GRAND

How to Build a Cheap Small-Block Chevy for \$500 (It's Reliable, Too!)

By John McGann / Photos: John McGann

→ I know what you're thinking: "Geez, here they go with another small-block Chevy! Stupid Chevy Craft. I'm canceling my subscription again!" Not so fast, Jack. Take a deep breath, find your inner peace, and give us a chance to make our case for this Vortec 350 build. We just made 320 hp and 398 lb-ft for about \$500, with no expensive parts and a tiny cam—all from a disgusting-looking, high-mileage engine we should have run screaming from. Honestly, we were surprised by the power this engine made. In all the guessing made while the engine was being assembled, none of us at **Car Craft** thought we would see more than 300 hp out of this combination. Follow along and see what you think, and if you have a better cost-per-horsepower alternative, please let us know.



Here's the short-block **Car Craft** started with, and it's one of those engines any self-respecting magazine would tell you to avoid. Scope out the sludge in the lifter valley and rust in the cylinders. Up to the challenge (or maybe just self-loathing people), we grabbed the engine, a Vortec 350 that came out of a 1998 Chevrolet 1500 pickup from Desert Truck and Auto Parts in Coachella, California. We traded them parts we had for this core engine. Hey, they even let us keep the seatbelt we used to lift the engine into our truck.

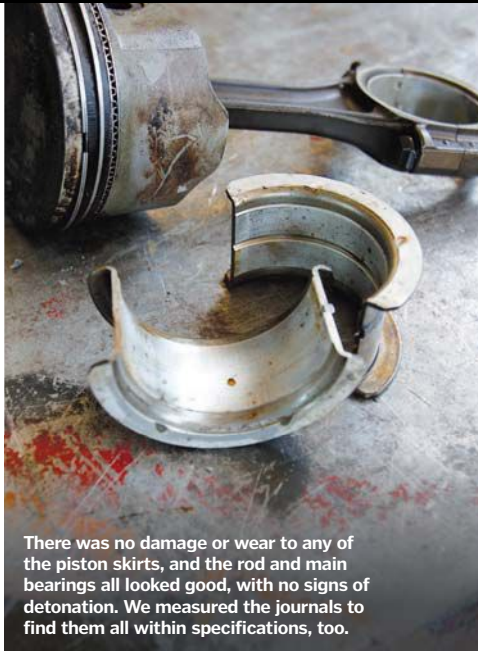




Back at IMM Engines in Indio, California, we tore the engine apart, not exactly sure what to expect. We were pleasantly surprised, however. All that built-up sludge was hiding an engine with very little wear.



We measured the bore sizes, and all showed minimal wear. The average was 4.002-inch (new engines should have a 4.000-inch bore). Measure the cylinders with an inside micrometer (*shown here*) or a dial bore gauge. Don't rely on telescoping gauges (snap gauges), because they aren't accurate enough.



There was no damage or wear to any of the piston skirts, and the rod and main bearings all looked good, with no signs of detonation. We measured the journals to find them all within specifications, too.



We also checked the thrust surface of the crankshaft, which can be a high-wear area. It was fine, as was the sealing surface on the crank for the rear main seal, which is a one-piece design for all Vortec engines.



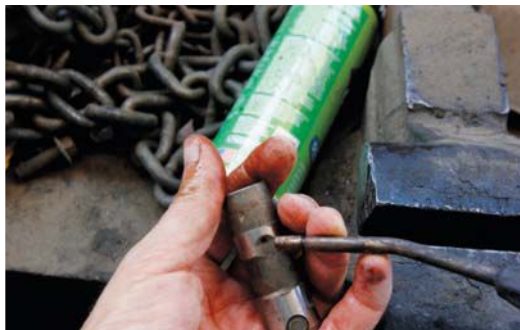
Another area we paid close attention to was the oil pump and pickup. We checked the screen for any scary bits of metal or other alarming material like blobs of silicone (which could indicate a previous shoddy rebuild). Though it looked like hell, the oil pump was in good shape.



We decided to use some of our budget to have all the parts we planned on reusing cleaned in the hot tank. Yes, you can clean everything yourself with degreasers, but that is a huge time commitment—we've done it before. You also need to be aware of local environmental regulations. Some regions of the country may not allow you to clean oil-contaminated parts without some sort of reclamation system for the runoff. Often, you'll be better off paying a machine shop to clean the parts for you.



Fresh from the hot tank, our crusty Vortec block looked really good. Look at the crosshatch from the factory hone, which is good from top to bottom in all cylinders. There was rust damage in a couple holes, but we ultimately decided to put the engine back together without running a brush hone through it like we had originally planned. The cam we installed is used; it's Chevrolet Performance's hydraulic roller with 196/206 degrees duration at 0.050, 0.431/0.451-inch lift, and a 109-degree lobe-separation angle. Brian Hafliker of IMM Engines bought it from a customer who upgraded to a bigger cam in his HT383 crate engine.



Because they were submerged in sludge for years, the lifters were especially difficult to clean. We soaked them for hours in solvent, blew them out, and soaked them again. Note the oil residue exiting the top of the lifter as we blew compressed air into the oiling hole on the side of the lifter.



We cleaned the piston tops with a wire wheel and rooted the carbon buildup out of the ring lands with one of the old rings from the engine.



The paint on our oil pan didn't agree with the solvent in the hot tank, which left it peeling and flaking off. You don't want this in our oil, obviously, so we sandblasted the pan, hot-tanked it again, and flushed it with a ton of water. If you're working from home, soaking the pan with lacquer thinner will get rid of this paint, too.

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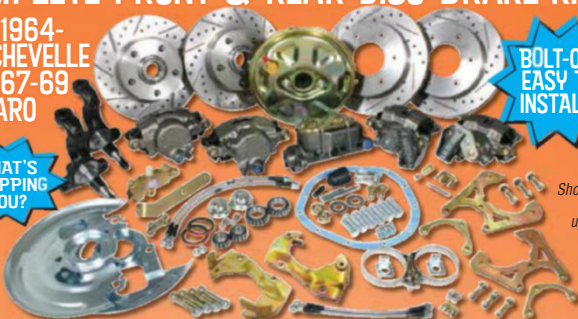
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After disassembling the cylinder heads and running them through the hot tank, we cleaned the deck surface with a wire brush and checked them and the engine block with a straightedge. An 0.002-inch feeler gauge wouldn't fit between the straightedge and any part we checked.



We checked the gaps of the new piston rings: we recorded 0.020- and 0.022-inch on the top and second ring.

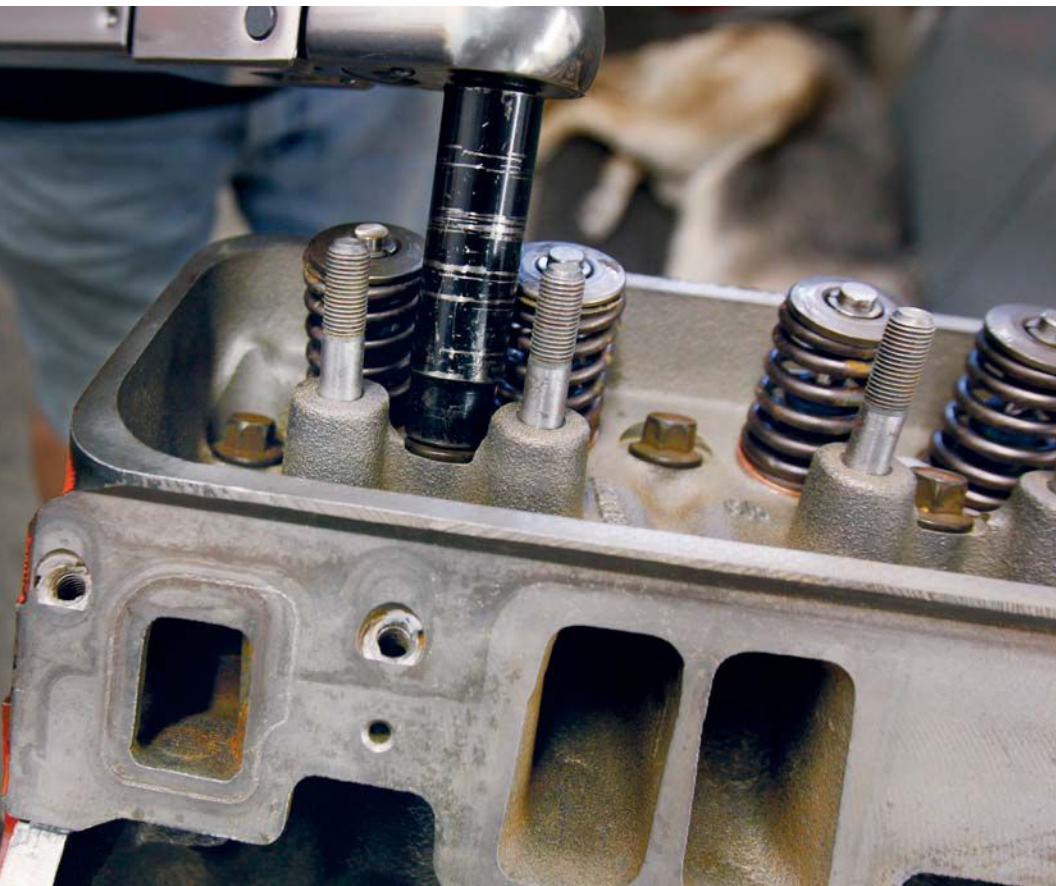


Discovering three bent intake valves was surprising. After cleaning the valves in the hot tank and removing built-up carbon with a wire brush, we checked the integrity of the heads by putting the valves back in the head and pouring water in the intake and exhaust ports. Water leaking past the valves indicated a problem. To verify, Brian checked the questionable valves in a machine. Note that the shiny area of the seat doesn't form a continuous ring around the valve. These valves don't seal completely. We replaced them with three old valves Brian found in a used-parts bin.



The main and rod bearings were replaced with stock-style replacements. We also reused the main and rod bolts; these are not torque-to-yield bolts, so it is OK to use them again.

We also reused the head bolts, valvesprings, spring retainers, and keepers. Note the use of a shim under each valvespring. Brian checked the spring rate and installed height and determined he could shim up the stock springs a little bit without going into coil bind based on lift numbers from our new-to-us camshaft. Though the Vortec cylinder heads are among the best production heads from the factory, their tall valve-guide bosses really limit the amount of valve lift possible before the spring retainer crashes into the valve seal and guide. You can machine the guide bosses down to free up room for more lift, but that would have put us past our target budget, so we will save that expense for a later version of this build.



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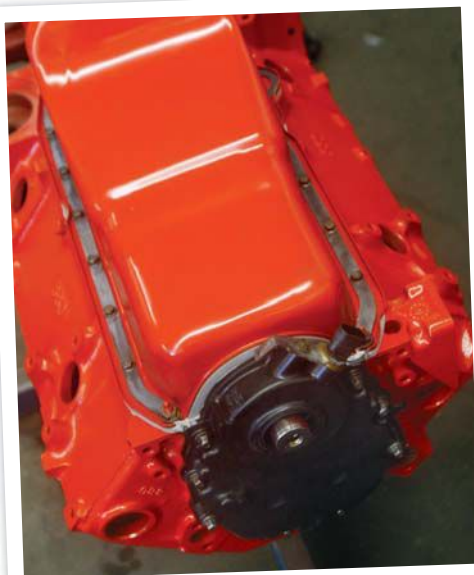


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The stock timing cover is something we probably should have replaced, but didn't; it was the only thing that leaked once we had the engine running on the dyno. The cover is made from molded plastic with a rubber O-ring-type seal around the outer edge and a neoprene crank seal. GM recommends replacing the cover, and in fact, the rubber seals aren't available separately from the timing cover. Because the crank seal felt good, we decided to reuse the cover and added some RTV sealant to the outer seal, but it wasn't enough to prevent a steady oil leak through one of the timing cover bolts. You can use a Gen I stamped steel timing cover, but two of the upper bolts are missing from the Vortec block, so be sure to use extra sealant in those areas.



After adjusting the valves and filling the crankcase with oil, we primed the engine and were pleased to see a steady 60 psi of oil pressure. Yes, we reused the stock pushrods and rocker arms, too.



Nearly ready to run, we bolted on Summit Racing's dual-plane intake manifold, a stock-replacement water pump, and the stock valve covers, then loaded the engine on the dyno cart.

→SOURCES

Chevrolet Performance; Chevrolet.com/Performance
Desert Truck & Auto Parts; 760/398-0106; DesertTruckandAuto.com
IMM Engine & Dyno; 760/347-5493; IMMEngines.com
Summit Racing Equipment; 800/230-3030; SummitRacing.com

PARTS LIST

Though we were able to wheel and deal with Desert Truck to get this engine, prices for a long-block at our local pick-your-part junkyards are about \$179.99. Many offer half-price days (usually on holiday weekends), so smart shopping can land you an engine similar to ours for less than \$100. Our MSD distributor cost \$150 from the local O'Reilly's Auto Parts, and Holley's Street Demon carburetors retail for about \$350 from Summit Racing. We didn't include those costs in our parts breakdown, because you may already have a carb and distributor or you could purchase used ones. If you are starting with nothing at all, this configuration can be built carb-to-pan for just over \$1,000, and for that money, you'd have a torquey, reliable engine you can drive anywhere for years to come.

DESCRIPTION	PN	SOURCE	PRICE
Engine Reman Kit	Call	IMM Engines	\$179.00
Chevrolet Performance camshaft	14097395	IMM Engines	80.00 (used)
Intake manifold	SUM-226018	Summit Racing	143.97
Hot tank & cam bearings	NA	IMM Engines	100.00
TOTAL			502.97

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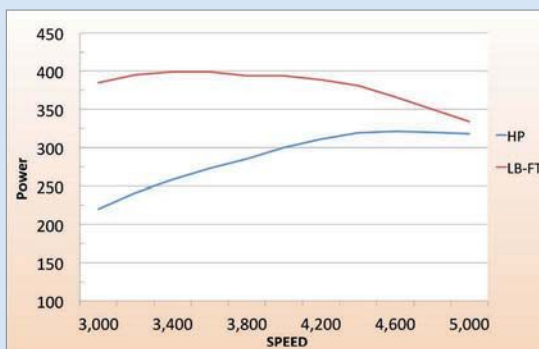
ON THE DYNO

Once hooked to IMM's DTS engine dynamometer, we installed an MSD HEI distributor, which came with a cam gear compatible with our roller cam, and Holley's 750-cfm Street Demon carburetor. The engine fired on the first revolution of the starter, and we ran the engine at 2,500 rpm for about 10 minutes to let the rings break in. All power pulls were made with the oil temperature at 160 degrees Fahrenheit and water temperature at 140 degrees. The carburetor was installed out-of-the-box with no adjustments at all. The engine made best power with 32 degrees of total timing and we ran the distributor out-of-the-box as well, making no changes to the mechanical advance. The headers were a crusty pair of Hedman Hedders that Brian Hafliger of IMM Engine & Dyno keeps for dyno testing. They have 1½-inch primary tubes and 3-inch collectors, and we installed race bullet mufflers to the collectors. The engine idled quietly at 800 rpm and was done making power at 5,000 rpm, at which point we feel we were limited by the cam, because we know these Vortec heads can support more than 400 hp. A cam with more duration and lift would take better advantage of the flow potential of the Vortec heads, but would also require machining the

valve guides, which is something we will do at a later date when we have a higher budget to work with.

Overall, we like the idea of using a Vortec engine as the basis for a budget small-block Chevy build. The Vortec's factory roller cam will ultimately save you money, because conversion roller lifters in an older engine are expensive (assuming you would eventually want to use a roller cam). Having a one-piece rear main seal and one-piece oil pan gaskets drastically cut down on oil leaks, compared to older small-blocks. The engines received quality machining from the factory, and even high-mileage engines like ours still exhibit very little wear. The rotating assembly will stand up to some abuse, too, and we are seriously toying with the idea of putting a turbocharger or two on this engine and see how it holds up. Otherwise, this would be a great build for a daily driver. It starts instantly, will never overheat, and makes decent power and great torque. Plus, it will last for years because we reused what we safely could and replaced the wear items with good parts. This engine is ready for another 100,000 miles of usable life. ☑

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3,000	220	385
3,200	241	395
3,400	258	399
3,600	273	399
3,800	285	394
4,000	300	394
4,200	311	389
4,400	319	381
4,600	321	366
4,800	320	350
5,000	318	334



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“Do you really want to trust your \$8,000 engine to a \$50 pump?”

The Moroso in-house DTS dyno gets steady use validating new oil-system products and also helping to further refine existing offerings.

OILING SYSTEMS 101: MOVING THE LUBE

Your Engine's Oiling System Lets It Live—Here's a Roundup of Facts to Help You Make the Right Choices

By Steve Magnante / Photos: Courtesy of Moroso and Steve Magnante

➔ Like our body's cardiovascular system, an engine's oiling system stands between a long, healthy life and sudden death. Maintaining a micron-thin film of lubricating oil between all moving surfaces takes the right combination of pump, pan, pickup, and other components. We sat with Moroso Performance Marketing Manager Thor Schroeder for an enlightening Q&A session.

CC: Way back in the 1960s, Dick Moroso offered one of the first commercially available deep-sump oil-pan kits. Ever since, product testing has been a core component of success.

How do you know what's going to work?

TS: Over the course of a year, Moroso does hundreds and hundreds of dyno pulls using our in-house DTS dyno. During the development of a new oil-pan design, Moroso builds versions with transparent windows and uses high-speed cameras and strobe lights to analyze how different features affect a certain oil-pan design. This is done so that when the oil pan hits the marketplace, it is assured that it is a top performer.

CC: Years ago I did an interview for *Car Craft* sister publication *Hot Rod*

magazine about Rick Moroso Jr.'s then-new 2001 C5 NMCA drag-race Corvette and was shocked when he told me he ran zero-weight oil circulating at a maximum of 30 psi. What's the story with oil pressure versus volume?

TS: The safe rule of thumb is that you want to see 10 psi for every 1,000 rpm. Street cars are very happy here, though racers frequently violate this notion with abandon. The LS-based engine in Rick's C5 Corvette was built with very close control over parasitic losses. Yes, the 30-psi maximum oil pressure was low by conventional standards, but the bearing clearances and coatings made it live on the strip. The key is picking

Moroso partners with racers and engine builders from all aspects of motorsports to field-test its products. Pro Mod and NMCA hitter Pat Musi's naturally aspirated, huge-cube thumper wears the latest in high-end dragstrip oiling attire.

the right oil pump to suit the oil-pressure demands of the engine and what it is going to be used for. One fallacy is that good oil pressure is great and more is even better. The problem with running too big of an oil pump is that the pump will keep bypassing. Each time the pressure-relief spring toggles, it puts extra pressure on the distributor drive components [on most traditional V8s] and the bypass spring itself.

CC: How about dry-sump systems?

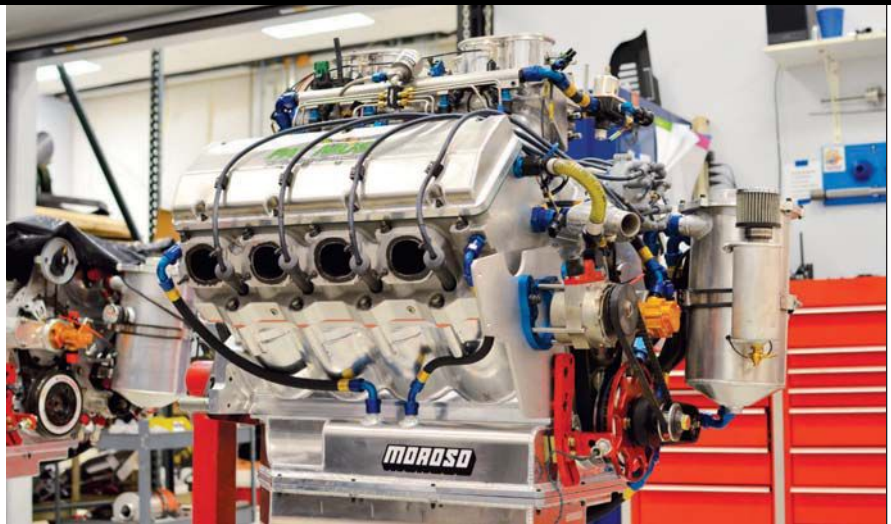
TS: Dry-sump oil systems are the safest, most dependable oiling systems available. They're popular in forms of racing that the rules allow them, especially where low chassis height is important for good handling and for horsepower gains. Horsepower gain is maximized because there is virtually no oil in the pan and no internal pump, allowing the windage tray or screen to run the full length of the pan. Other advantages of a dry-sump system include a remotely mounted oil tank for increased capacity, the ability to easily add remote oil coolers, more consistent oil pressure, adjustable oil pressure, improved scavenging, and increased ring seal due to greater oil-pan vacuum.

CC: Knowing that lowered suspension settings are popular these days, the dry-sump system gets us away from the headache of the low-hanging, extra-capacity pans required in wet-sump systems. What else is involved?

TS: A dry-sump oiling system consists of the sump pump itself, which can be one through six stages. The stage designation refers to how many scavenge and pressure sections the pump has. A four-stage oiling system would have three oil-pump pickups in the oil pan. Each one of these pickups would be plumbed to the three scavenge sections of the oil pump. With this oiling system, a full-length windage tray can be used inside of the oil pan and the oil can be stored outside of the oil pan in a baffled dry-sump tank.

CC: Can a wet sump work as well as a dry-sump system?

TS: Yes and no. I know that sounds confusing, and let me explain. Even



One of Rick Moroso Sr.'s first products was this deep-sump pan for 1962-1966 Chevy II applications. Note JMS Racing Engines' Jeff Johnson's right hand resting atop the special notched section. That's where the stock Chevy II steering arm goes. Before this pan's arrival, Chevy II racers were forced into using stock, shallow-sump pans on their high-winding small-blocks. It continues to be a big seller 40-plus years later.



The 1968-1974 V8 Nova pan is also a big seller. Note the stock pan's lazy sump profile (orange). Oil is free to surge forward on hard braking, potentially uncovering the pickup and starving the bearings. The abrupt, vertical contours built into Moroso's replacement help keep the oil in the sump.



Moroso calls them “power pouches,” and their side-mounted location on the vertical walls of the pan adds oil capacity without reducing ground clearance. The different shapes are needed to suit vehicle architecture without making contact.

though Moroso sells three different series of dry-sump pumps, production and custom dry-sump oil pans, and production and custom dry-sump oil tanks, certain applications are better suited to a wet-sump oiling system than a dry-sump oiling system. On street applications, all but the most exotic and high-performance street cars are better suited to a wet-sump system. This is because a dry-sump system adds complexity, cost, a user that has to be more mindful of what the system is doing, and more maintenance. That is not to say that there are not production cars out there that have dry-sump or external-oil-pump oiling systems as OEM. Some examples are the 2009-up Corvette ZR1, 2015 Camaro Z/28, and several Porsches.

CC: What are the primary differences between cast and billet wet-sump pumps? Are there functional differences, or is it a matter of reducing weight?

TS: The Moroso billet-aluminum, wet-sump oil pumps for the small- and big-block Chevy have a three-times-larger mounting area to prevent breaking and weigh 1 pound less than stock oil pumps and pickups. The inlet area size is increased to prevent cavitation, and the thrust bearing assemblies increase housing and gear life by resisting drive-shaft axial forces on the drive gear.

CC: What are your recommendations on which oil pump to use: high-volume, high-pressure, or standard-volume oil pumps?

TS: When making recommendations to customers, I use the following guidelines. If the customer has a rear-sump oil pan—where the deepest part of the pan is toward the back of the

vehicle—and the oil pump is in the front of the engine, with that big, long oil pump pickup tube in between, I would recommend that a high-volume oil pump be used. If the vehicle has an oil cooler, remote filter, an extra-capacity oil pan, is a street/strip car that also might see an autocross or go on a road course, I would recommend a high-volume oil pump. If the vehicle is being used for drag or is a street/strip that will only be raced in a straight line and has to run a stock-capacity oil pan, then I would recommend a standard-volume oil pump. This is to maximize the amount of available power. But the driver must be certain to keep a close eye on the oil-pressure gauge and react if there is a severe pressure drop. If you don't trust yourself to be on top of this detail, go for a high-volume pump.

Though partial windage trays are often mounted to the main bearing cap bolts, full-length windage trays bolt to the oil pan. The drainage louvers are punched to work with the clockwise rotation of the spinning crank (as seen from the front).

CC: Can users trust generic parts-store replacement oil pumps?

TS: Generally, yes, but remember, they're mass-produced and built to a price. Do you really want to trust your \$8,000 engine to a \$50 pump? Moroso offers a couple different options in wet-sump oil pumps. We sell oil pumps and oil-pump pickups for our oil pans separately, then we have a line of oil pumps and pickups that are already welded; that way, the end user does not have to worry about welding the oil pump and oil-pump pickup together and checking the height. Moroso also sells a line of cast oil pumps that are blueprinted. Our blueprinted oil pumps were developed in association with racing's most respected engine builders. Our CNC-machining operations ensure the



Press-fit oil pickup tubes have a reputation for sucking air and even falling off. The pen points to where a bead of weld can be applied to remedy both problems. Many quality pumps come pre-welded.

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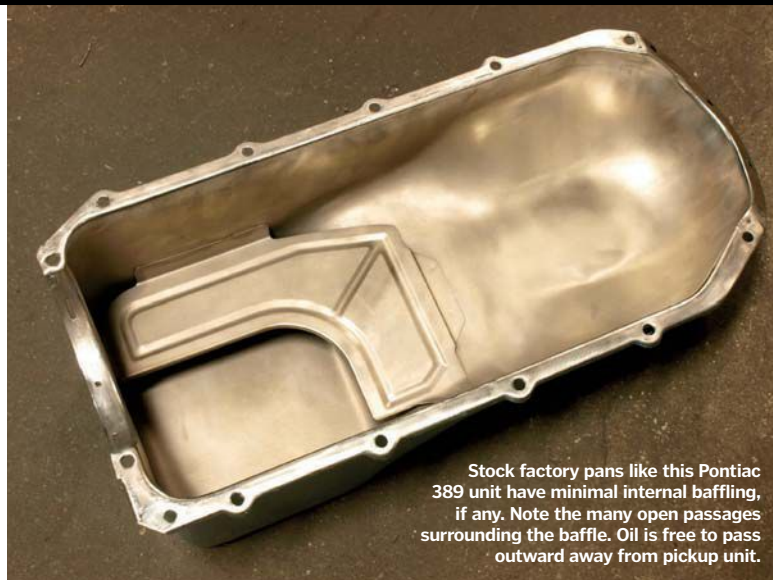
Aftermarket oil pickup tubes often replace the circular OE head with a more compact box. Note the integral support arm that bolts to the pump cover. This eliminates any chance of the pickup falling off. Moroso offers pre-welded pump/pickup assemblies as well as billet aluminum and blueprinted iron units to suit any wet-sump application.

tightest tolerances and most consistent performance of any cast oil pump in its class. Anti-cavitation slots and enlarged feeder grooves are ball-milled smooth, providing steady oil flow to each side of the gears for high-rpm lubrication, cavitation relief, and reduced spark scatter. Then we have our line of billet-aluminum, wet-sump oil pumps for when the customer demands more out of an oil pump. The Moroso line of billet-aluminum oil pumps have a housing that is machined out of 6061-T6 billet aluminum, which is stronger per pound than cast oil pumps with none of the problems that cast oil pumps have with porosity.

CC: How about windage trays?

TS: The term windage tray had been broadened to represent a couple different features in recent years. Often the sheetmetal plate that goes over the opening of the sump where it meets the body of the oil pan has been called a windage tray. This is actually the anti-slosh baffle, which helps keep the oil contained in the sump so that it does not get back into the rotating assembly and cause drag or aeration. The windage tray itself is the screen or louvered piece that is either mounted directly to the main caps of the engine, sandwiched between the block and pan, or positioned in the oil pan itself. It usually has a crank scraper as a component of it. At Moroso, our oil-pan and windage-tray designs live and die by our in-house dyno, and by outside testing by

By contrast, the anti-slosh shelf inside this Pontiac pan from Milodon is form-fitted to the walls to prevent oil migration. Four spring-loaded trap doors also keep oil around the pickup tube under all lateral load conditions. Moroso offers a similar unit.



Stock factory pans like this Pontiac 389 unit have minimal internal baffling, if any. Note the many open passages surrounding the baffle. Oil is free to pass outward away from pickup unit.

our group of top engine builders and racers. We feel windage trays are important in a proper high-performing oiling system.

CC: Do some engine types benefit more from windage trays than others?

TS: The answer depends on the engine's operating conditions. Engines that are static—like industrial power stations—generally don't need a windage tray. Engines with a big-box oil pan that keeps the oil away from the crank, or engines with a conservative rod-to-stroke combination, or engines that operate at 5,500 rpm or less see fewer benefits from using a windage tray. But engines that live in a more dynamic environment with severe acceleration, deceleration, rights, lefts, and quick up-and-down movements will see much more movement of the oil pan's contents. So, too, will situations employing confined oil-pan dimensions, larger stroke combinations, and operating speeds above 5,500 rpm. In those conditions, we have seen and heard of

windage trays freeing up to 5 percent horsepower on many engines. Controlling windage friction also reduces oil temperature and helps keep the oil at maximum density so it can work best.

CC: What can be done about controlling crankcase pressure due to blow-by and the inevitable fact that a certain percentage of combustion pressure is going to get past the rings and down into the crankcase?

TS: We've all seen cars that shoot oil out the valve-cover breathers on a full pass. Assuming we're not dealing with a worn-out engine, vacuum pumps are often used as a solution. The nature of a vacuum pump is to remove air, blow-by gases, and other contaminants from the crankcase of an engine. The vacuum pump's ability to remove the air in the crankcase results in overall engine vacuum. Vacuum will increase horsepower by allowing the use of low-tension compression and oil-control rings. These types of rings reduce frictional horsepower losses, blow-by, and



“The key is picking the right oil pump to suit the oil-pressure demands of the engine and what it is going to be used for.”

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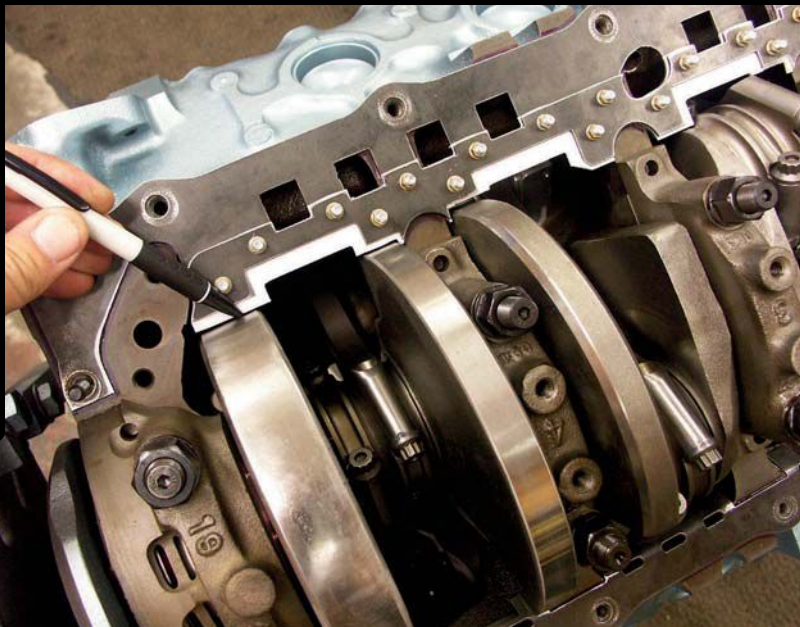
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Cutting parasitic drag is the same as adding power. For maximum effectiveness at wiping parasitic oil vapor down into the sump, crank scrapers must fit as close to the spinning crank and rods as possible—without making contact. This Ishihara-Johnson unit (Crank-Scrapers.com) uses a Teflon blade for easy shaping. Installation is time consuming but required for ten-tenths race applications.

intake-charge contamination, and aid in detonation prevention. Moroso's "purpose-built" racing vacuum pumps offer all these advantages and more.

Whether the engine is a normally aspirated small-block or a nitrous-equipped Pro Mod, what is needed is the vacuum pump itself, a vacuum-pump pulley, a crankshaft-drive pulley, belt, vacuum-pump line kit, a regulator, and a breather tank. For stock and lightly modified cars running factory positive crankcase ventilation [PCV] systems, a Moroso air-oil separator system can help reduce detonation and valve deposits. Plumbed into the PCV system, they capture oil mist and residual vapors that are otherwise returned to the intake tract. Moroso offers vehicle-specific kits for fast, easy installation.

CC: Though not employed as part of the normal engine oiling circuitry, tell us about the importance of oil accumulators.

TS: In the event of a sudden oil-pressure drop, we offer a pressurized backup system called an oil accumulator. Centered around an aluminum storage cylinder with billet end caps, a reserve of pressurized oil is available for instantaneous release if the engine oil pressure drops below a preset, safe minimum value. When the engine is running, oil pressure forces reserve oil into the accumulator and compresses the air ahead of it. But don't just assume these systems are a there as a last line of defense in emergencies. The oil-accumulator system can also be

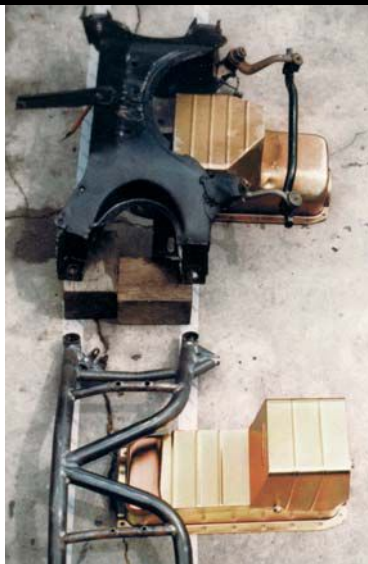
used to pre-lubricate the engine during dry starts, which is when up to 85 percent of normal wear occurs. Also, many racers incorporate them into the operational routine of the car during competition to restore full oil pressure after a hard launch, a severe corner, or brutal braking event. Once the danger is over, the system instantly re-primed and is ready for the next cycle. Stock-appearing classes and bracket racers forced by rules to run stock-type oil pans can benefit from an accumulator. They'll make up lost pressure on a hard launch as well as at the finish line, where hard braking might be needed to avoid breaking out of the dial-in number.

CC: Are there any special tips or pointers to share regarding oil accumulators?

TS: To function properly, it needs a valve assembly and ours comes standard with a manual ball valve. This valve has to be manually opened by hand before starting the car, to prime the oil circuits, and then manually closed before turning the engine off. We do offer optional solenoid pressure valve kits in 15- to 24-, 35- to 40-, and 55- to 60-psi discharge and refill settings. These automatic valves are handy in situations where accessing a manual valve is difficult.

CC: Thanks for taking time to offer your advice. Any final thoughts?

TS: Moroso has been helping car crafters and racers of every type for about a half century, and we continue to



Don't forget that changes to your chassis and suspension can trigger the need for a pan swap. Replacing the stock Mopar K-frame (top) with a lightweight tubular replacement requires a rear sump pan and extended pickup. The extra suction distance should be crutched with a high-volume pump.



Noted for its indestructible nature, your author managed to (almost) kill a Mopar Slant Six. The oil-pump drive-gear teeth were not up to the task and wore so thin the pump stopped turning. A standard pressure pump solved the problem.



Most solid-roller cams must be teamed with bronze distributor/oil-pump drive gears and require frequent visual inspection for wear. Many feature removable gears for easy rebuilding.

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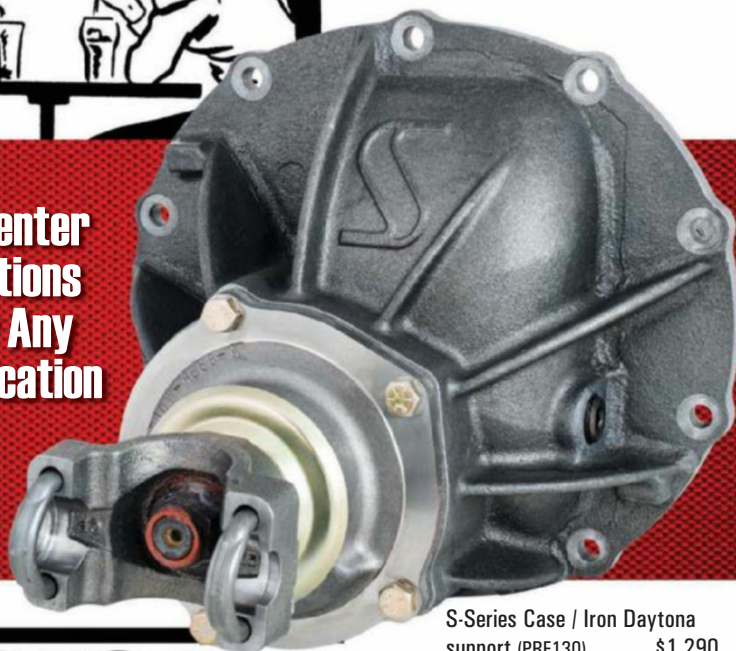
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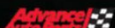
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When running a stroker crank, always confirm windage tray clearance. The pen points to contact with rod bolt. Special extra-depth trays are available to remedy the problem (top).

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OIL SYSTEMS: LESSONS LEARNED

Before closing this story, I'd like to share some of my personal oiling-system experiences gathered over the last 30 years. My hands-on background has mostly been Mopar-oriented, but the lessons learned apply universally. Though I've installed high-volume oil pumps on all of my 340 and 360 small-blocks and 383, 440, and Hemi big-blocks, my eyes almost popped out of my head the first time I saw what happens to a garden-variety, parts-store oil filter at 100 psi.

The engine was a 520ci Hemi with a basic wet-sump system and simple high-volume pump. With a pan full of cold 20W-50 oil, the straight walls of the filter body "breathed" outward in harmony with the tachometer when I blipped the throttle. Though nothing leaked, the Fram PH8A thin-wall filter body and single-crimp construction was immediately replaced by a Fram HP1 thick-wall filter. I'm glad the Mopar big-block/Hemi architecture places the oil filter where it is easily seen. Trust me, Chevy guys, under the same pressure conditions, your filter is doing the same thing—you just don't see it as easily. Lesson learned: Always run a thick-wall, racing-type filter if pressure exceeds 70 psi, hot or cold.

Speaking of high-pressure oil pumps, a Slant Six build taught me a painful lesson about excessive oil pressure. Thanks to its extreme under-square

nature (3.40 bore x 4.125 stroke) and restrictive port and valve dimensions, the tall-deck 225 is hard pressed to achieve 5,000 rpm. As such, a stock replacement oil pump is perfectly adequate and will display 50 psi with normal bearing clearances. But, no, I had to try out a thick-body, high-pressure unit. The car was a 1962 Valiant two-door sedan with a die-cast aluminum block, Doug Dutra/Clifford Hyper-Pak long-ram intake, Carter 400-cfm AFB, headers, a 0.510-inch lift solid cam, and 3.91:1 gears. After one week of street driving, the engine lost oil pressure on Los Angeles' crowded 101 freeway during morning rush-hour traffic. Thankfully, I have a habit of frequently scanning the gauges and shut it off before meltdown.

Disassembly revealed eradication of the oil-pump drive-gear teeth. As it turns out, the Slant Six oil pump gear is

only 1 inch in diameter and didn't take kindly to the combined strain of elevated pressure and volume, 20W-50 oil, and extended 4,000-rpm freeway cruising. Fresh rod bearings and a box-stock oil pump put me back on the road. Lesson learned: Too much oil pressure can be as bad as too little.

A final observation involves a trio of engines I've built equipped with roller cams and solid roller lifters. In each case—the aforementioned 520-inch Hemi, a 512-inch Max Wedge, and a Chevy 502—the cams were ground from billet steel, so I followed the manufacturer's urgent warning that bronze distributor/oil-pump drive gears be used with them. By design, the softer bronze gear is sacrificed so you can enjoy the deep-breathing, high-rpm benefits of the roller cam's radical lobe profiles.

Make no mistake, the bronze gear wears away with use. The trouble is how there's no way to monitor how much life is left in the gear without a physical inspection. Naturally, a high-volume, high-pressure oil pump intensifies the situation. Twice, I elected to inspect the gear and on both occasions was met by the sight of teeth worn to half thickness. Lesson learned: Inspect bronze distributor/oil-pump drive gears at least once a year, or look into the availability of the new breed of plastic composite gears for your application. 🛠️



Don't forget that the engine block is part of the oiling system and can benefit from flow improvements. On big-block Mopars, the stock oil pickup tube can be enlarged and re-tapped to accept a 1/2-inch-diameter replacement. Regardless of engine type, inspect all visible oil passages, and where accessible, grind away casting flash and blend galleys to reduce flow restrictions.



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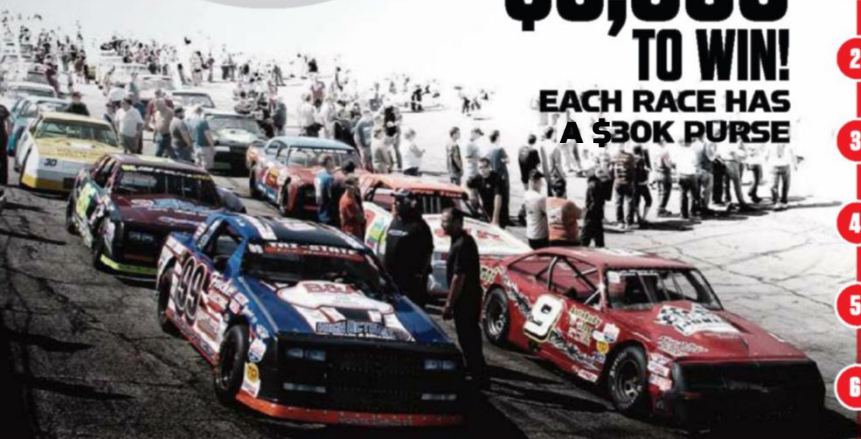


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As this image shows, the Ford 4.6 DOHC is visually impressive, with width in excess of a Chrysler Hemi. True power comes when these relatively small-displacement engines are force-fed. Reader Jonathan Hartzen's supercharged 2004 Cobra mill's 390 ponies only scratches the surface.

2004 MUSTANG COBRA ORGAN DONOR

Jonathan Hartzen; via CarCraft@carcraft.com: I am looking to begin a car project in the next year or two, and I have a 2004 Mustang Cobra that will serve as my donor car. I am mechanically inclined and do most of my own car work, but haven't done anything major like rebuilding an engine or even remove a transmission. I am looking to build a car and thinking about purchasing a Factory Five '33 Hot Rod because I like the way it looks, handles, and they are designed to accept a Mustang drivetrain. Before I lay down \$20K for a kit car, are there other companies or places I could use the driveline without a lot of fabrication work (i.e. bolt in)? I am not opposed to Mustang rollers, but like the looks of older cars and would primarily use this as a commuter vehicle and the occasional road-race event or dragstrip pass. Thanks for your help, and keep up the good work with the magazine!

Steve Magnante: Thanks for reading **Car Craft**, though from your prewar tastes, you're probably missing *Rod & Custom* (R.I.P.) as much as we are. That said, are you sure your 2004 Mustang Cobra is beyond salvation? With only 5,664 built (3,768 coupes, 1,896 convertibles) it's an up-and-coming collector machine, not to mention a fun daily commuter with the ability to nudge 25 mpg. Let's remember, unlike the naturally aspirated 1996–2002 Cobras, Ford added an Eaton M112 supercharger, iron engine block, Manley H-beam connecting rods, and other goodies in 2003. The legendary Terminator was born, power jumped from 320 to 390 hp overnight, and Mustang finally had the muscle-car power it deserved. Are you sure it's beyond salvation? Assuming it is, the Factory Five '33 Hot Rod kit would be an excellent receptacle for its supercharged 4.6 Cammer and T-56

six-speed stick. Though there are many reputable kit-car manufacturers in operation, Factory Five (Wareham, Massachusetts; info@factoryfive.com) is one of the best. I looked over the Factory Five website and the '33 Hot Rod complete kit seems to include just about everything else you'll need for the \$19,990 price point. The one gray area I encountered centers on the rear suspension. The Factory Five site describes the '33 Hot Rod as being supplied with a four-link rear suspension and Koni coilovers. The assumption here is that a solid rear axle is intended (but not supplied). As you probably know, all 1964½ through 1998 Mustangs rode on solid rear axles that are easily swapped under a kit car like the '33 Hot Rod. But in the case of your 2004 Cobra, a peek under the tail will reveal IRS. New-for-1999 and installed only under Cobra-spec Mustangs, this IRS setup is designed



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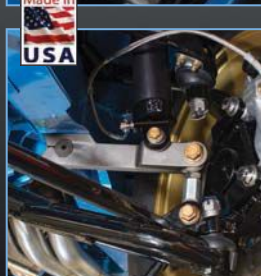
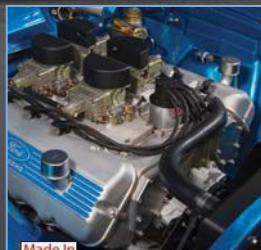
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to bolt up to the same factory mounting points as the four-link, coil-sprung live axle used under all same-year non-Cobra Mustangs. It features the same beefy 8.8-inch ring gear and traction lock assembly, though the half-shafts are known to fail under high-power, high-traction drag-strip conditions.

My suspicion is the Factory Five kit is not meant to absorb your Cobra's IRS unit, so be ready to source a suitable 8.8 replacement axle from a non-Cobra Mustang GT. It'll have the same good limited slip while including the rigid tubes needed to lock into the kit's four-link rear suspension scheme. Regarding your concerns about lacking the skill to execute the job, I'd say dig in and go for it. You stand on the edge of a fantastic experience. Though **Car Craft** is generally focused on postwar machinery, the thrill of building your own high-performance machine is universal and knows no bounds. Have fun and jump on it. Send us pictures when you're done.

MORE INFO

Factory Five Racing;
508/291-3443; FactoryFive.com

PONTIAC 350: JUNK OR JEWEL?

Ron Kanzaki; via CarCraft@carcraft.com: I'm a low-dollar street and strip enthusiast with an open mind. At my local bone-yards, I'm constantly seeing Pontiac 350s going into the shredder, some even with four-barrel carburetors still attached. What's the deal with this engine, and is it worth anything from a power standpoint compared to a Chevy 350?

Steve Magnante: Great question. In bone-stock form, as found in a typical same-year family sedan or station wagon with two-barrel or base four-barrel induction and single exhaust, I'd have to say the Chevy 350 would be the most peppy of the two. It comes down to the Bow Tie's smaller 2.45-inch main journal diameters (versus

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Pontiac 350, 400, and 455 blocks cast between 1970-1975 bolt right into any 1961-1979 Pontiac, thanks to multiple-choice, engine-mount lugs shown here. Blocks from other years may require readily available mount adapters.

the Poncho's 3.00-inch) allowing higher peak rpm and the greater flow capacity of its cylinder heads. By the way, both engines benefit from nearly identical stud-mounted, stamped rocker arms with Pontiac engineers coming up with the design first, then sharing it with Chevy. Beyond that, I won't get into a shouting match over which engine family has the most potential. Instead, let's focus on the somewhat unloved Pontiac 350.

As you've observed, the Pontiac 1968-1977 350 has long been overlooked due to the fact there used to be lots of 400s in boneyards, often sitting in the next car over waiting to be plucked. Since cubes are king, why mess with the 350? Or so the logic went. But now that the Pontiac 400 has become nearly as scarce as the holy-grail 455, car crafters looking for something different are taking a second look at the 350. And guess what, with its 3.875x3.75 bore and stroke, the actual stock displacement is 354 cubes! It's as if Pontiac said, "Keep the tip, thank you very much!" Naturally, any two-barrel induction must go, and while the factory-issue Rochester Quadra-Jet carburetor has plenty of performance and tuning potential, simpler and budget-oriented square-bore induction is the better bet. There are plenty of dual- and single-plane aftermarket aluminum castings to suit any build, and since Pontiac didn't fiddle with block-deck height, the

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same manifolds fit the 350 as well as its 400 and 455 siblings. With good machine work and studs replacing bolts, the 350's two-bolt-main block is sufficiently stout to handle 500 hp, and with its 3.00-inch mains, it escapes most of the high-rpm oiling problems associated with the 455 and its 3.250 mains.

For maximum swapping ease, the best blocks are those cast between 1970-1975. These bear five engine-mount bosses on each side (visible just above the oil-pan rail) and will bolt into any 1961-1979 Pontiac vehicle using the stock engine mounts that came with the car. During the 1970s, Pontiac manipulated compression ratio with combustion-chamber volume and with machined scallops at the tops of the cylinder bores. Blocks cast between 1971-1973 have scallops adjacent to the exhaust valve to help deliver 9:1 compression, while later blocks gained another scallop adjacent to the intake valve to help reduce compression into the dreaded high-7s. The good news is how these scallops put distance between the valve heads and the bore for reduced shrouding, especially when jumping from the stock 1.96/1.66 valves to 2.08/1.71 replacements.

The bad news is that the scallops must be considered when ordering custom high-compression pistons because they add significantly to effective chamber volume. Camshaft lift must be restricted to 0.600 inch or less due to the 350's small 3.875-diameter cylinder bore. Higher lifts, especially with over-size valve diameters, will crash the valves into the block—scallop or no scallop. This threat also affects earlier 287 (1955) and 326 (1963-1967) engines, which have even smaller bores. Pontiac used cast cranks in virtually every commonly available V8 they made (including the 350), but with proper preparation and oiling, they'll handle 450 hp. The same goes for the rods. Made from proprietary Arma-Steel, a high nodular cast-metal alloy patented by GM in the early 1960s,

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stock rods are safe to the same power limit as the block and crank after passing inspection.

The real trick for Pontiac 350 builders came from Ken "Ace" Brewer of Pacific Performance Racing/Tomahawk Performance Products in the form of a 383-inch stroker kit. First offered in 2007, the pre-balanced kit's \$1,600 price tag included a new cast nodular 4-inch stroker crank with BBC-sized 2.20 rod journals, forged 6.800-inch 4340 I-beam rods, forged 3.905-inch-diameter Probe pistons, pins, and bearings. Brewer closed shop in 2013, but parts for this 383 stroker kit can still be found online. Back in 2007, I witnessed several 460hp, 435-lb-ft dyno pulls on a Brewer-built Poncho 383 running 9.6:1 compression, breathing through ported iron heads and turning a reasonable 6,200 rpm. The full story can be found in the Dec. 2007 issue of *High Performance Pontiac* magazine. And speaking of iron Pontiac heads, production heads vary in chamber volume from 70 to 114 cc with those installed on 1971-and-later engines bearing the larger 92- to 114cc chambers for reduced compression. Though 350 heads can be massaged, a set of Edelbrock's latest aluminum Pontiac offerings (with attention paid to valve-to-bore clearance) would be far more cost effective. You're on the right track, Ron—the Pontiac 350 may not replace Chevy's same-sized rodent, but there's a lot of potential. Let's stop throwing them away.

MORE INFO

Edelbrock; 310/781-2222;
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THIS GUY'S GARAGE

The dark horse is a black 1970 LS5 convertible with a red interior that took 15 years to find. It's a matching-numbers M-22 car he bought in California. He had it shipped home because, "I wasn't going to drive it all the way home with 4.10 gears!"

This is the phantom of *Chuck's Garage*: a flamed, 1966 two-door Chevelle wagon that Chevy never built. Chuck started with a four-door 1966 California wagon and used the window frames and other pieces from a rusty two-door 1964 wagon to complete the illusion. It's a driver with a 350 crate engine, Holley EFI, and a 700R4 with Hotchkis suspension and Baer brakes.

"That's my COPO tribute car," Chuck says. It is a 40,000-mile, original-owner car that had been garaged its whole life. He wanted to keep it as original as possible before modifying. "It still has all the original weatherstripping, except for the trunk." The motor is a Gen VI 454 with a TCI TH400 trans and a 3.31:1 12-bolt.

The burgundy 1970 Chevelle is a California Malibu and one of the few Hanson family small-block cars with a 383 and a TH350 trans. But it travels well with factory A/C, tilt wheel, a power top, steering, disc brakes, and windows.

This yellow 1966 SS396 convertible claims the family longevity title; Chuck bought it way back in 1976 when he was in school, using student-loan tuition money to float the purchase. It's a 325hp, four-speed car with 3.08:1 gears, making it a great road car.

This little 1975 Laguna S3 is an amazing example of grandma fresh. Chuck bought this from a 90-year-old lady outside of Seattle. When he arrived, she had commissioned a dealership to install new tires, exhaust, and an oil change (at no extra charge) just so he'd make it home OK. The S3 shows 72,000 miles on the clock.

See if you can pick out the common thread among the cars here. Here's a hint: think big-block. This blue 1969 Bel Air is an all-original 427 four-speed California car. The engine is not original, but it's an L72 425hp 427.



Chuck used this 1969 Chevelle frame to mount a complete LS engine and 4L60E trans to shoot a full series of *Chuck's Garage* videos on converting an early car over to Holley EFI. You can find the video series on YouTube or at Holley.com.

Chuck says the 2014 Harley Street Glide "is my therapy machine. I just get on and ride." On the other side of the wall to the far right is Chuck's "office" with another couple of cars and a collection of other goodies.

CHUCK HANSON / Greenbrier, TN

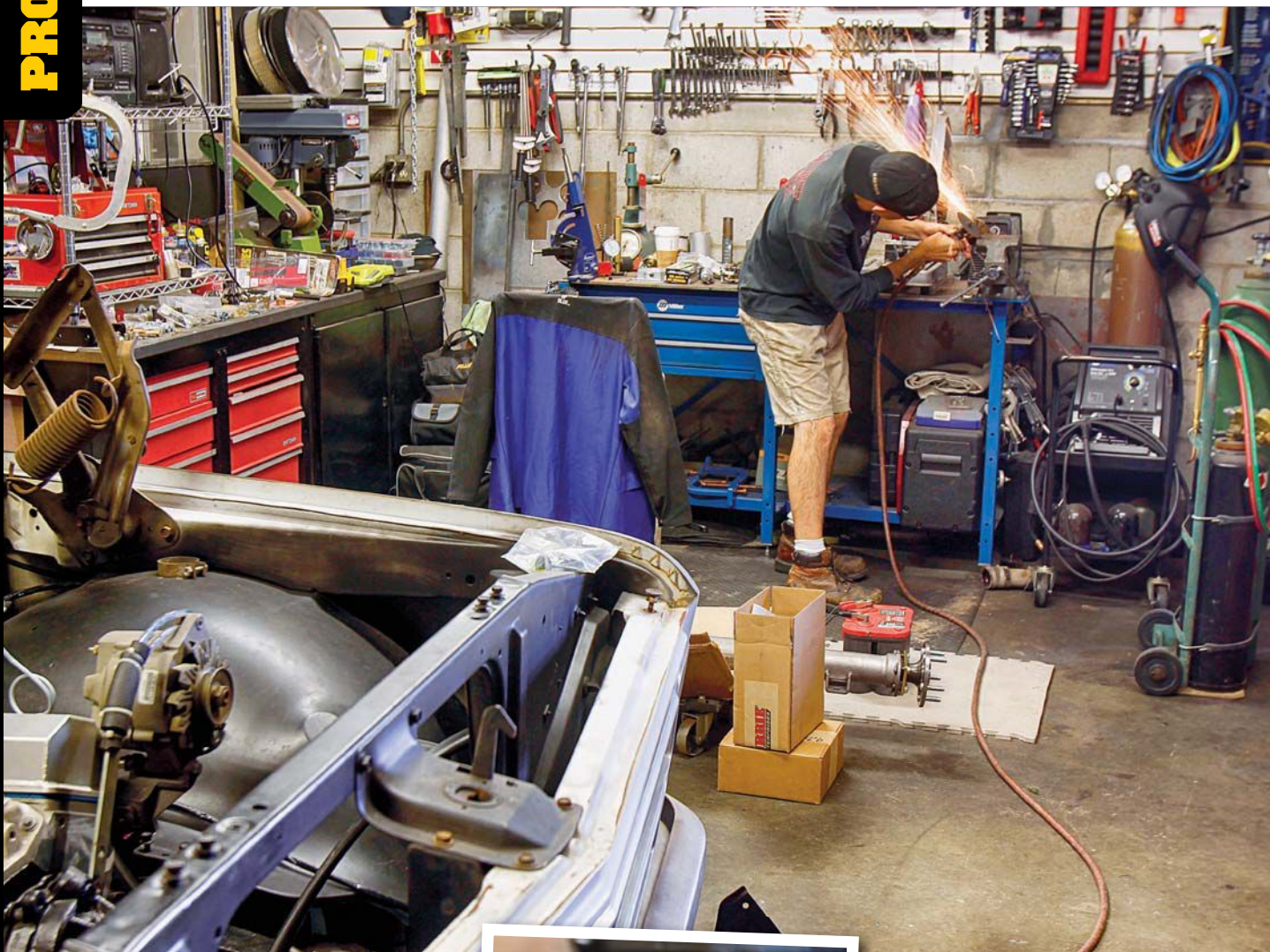
If you're a **Car Craft** reader, you may recognize the name Chuck Hanson. But you probably know his name anyway. Chuck is a longtime car crafter and was actually a **CC** staffer back in the mid-1980s. He later gained significant notoriety when he shared airtime with cohost Joe Elmore on *Horsepower TV*. You can also check him out on *Chuck's Garage* on YouTube doing video work for Holley. If you're a Chevelle guy, you may have also been a member of the American Chevelle Enthusiasts Society (ACES) Chevelle club he ran with this wife, LaRae, for many years. It should be obvious from this photo that even though he's traded the long hours in front and behind the TV camera for other pursuits, his passion for Chevelles has certainly not wavered. Let's just say that for the last several decades there has never been a time when there wasn't at least one—and usually several—big-block Chevelles and Camaros in his possession. He still finds it easy to stay busy because he electronically scours the country looking for that next acquisition. He's famous for jumping on a plane, flying the entire breadth of the country, buying a car that he'd never seen before, and driving it home. Chuck has dozens of stories like that. So the next time you see him at a swap meet or car event, say hello and ask him to tell you a story. Our favorite is when the **Car Craft** Grand Prize Giveaway Dodge Dart blew the transmission in the middle of the night in the mountains of Colorado back in 1985.

By Jeff Smith / Photo: Chuck Hanson

PROJECT CAR UPDATE

Truck Norris: The Little Details

By John McGann / Photos: John McGann



Yes, we can all relate: it's the little details that always take more time than you expect.

Car Craft's 1967 C10 project is so close to running, and we are brimming with anticipation at the prospect of having it back on the road. Our travel schedule has kept us from devoting as much time to working on it, but we're plugging away on Truck Norris any time we have a few free minutes. Here's what's been going on.



Our new steering column from CPP is installed and fully functional. Fiddling with the rag joint took a few hours more than it should have, though. We had to rebuild the original one, rather than install the new one CPP included in the kit. Our truck's original steering-box input shaft is splined all the way around, unlike most newer units that have an indexing flat (a small section without splines). The replacement rag joint from CPP was designed to fit the latter type of input shaft.

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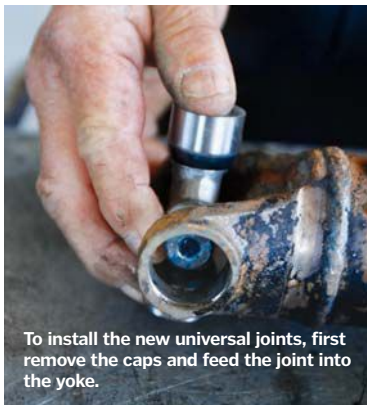
To rebuild the old rag joint, we first had to remove the rivets holding the upper and lower section together. We did this by first grinding the heads until they were flush, then driving them out with an air hammer.



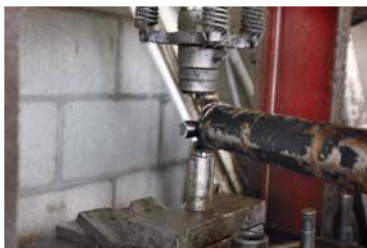
CPP's steering column kit includes a cut-to-fit intermediate shaft to connect the steering box and rag joint to the column at the firewall. We needed to trim about 2 inches from the intermediate shaft in our chop saw, then we were able to button the whole assembly up.



Replacing the universal joints seemed like a good idea, especially considering they looked as old as the truck is. That process begins by driving out the old joint.



To install the new universal joints, first remove the caps and feed the joint into the yoke.



Then press the caps into place—first one side, then the other. Be careful not to let any of the little needle bearings that ring the cap fall out of place. The caps won't seat fully, and the bearings can get bent by the press.

Back in the warehouse, we're tackling the last remnants of the braking system, bleeding the brakes, and installing the parking-brake cables. Truck Norris should be roadworthy soon. ☑



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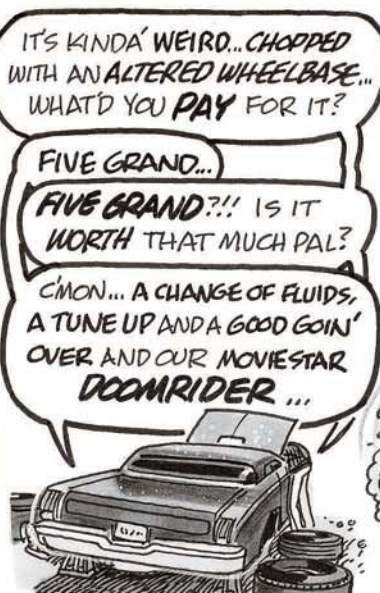
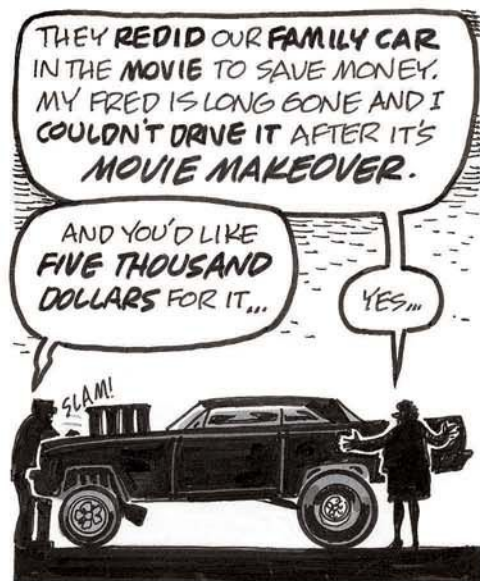
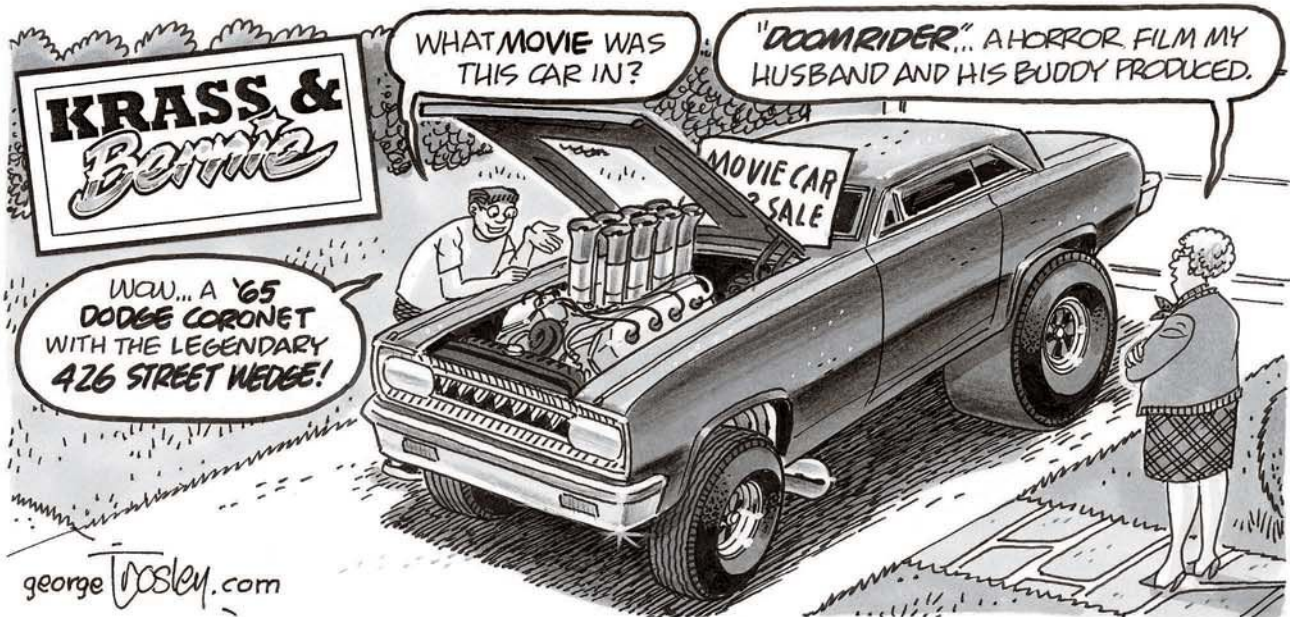
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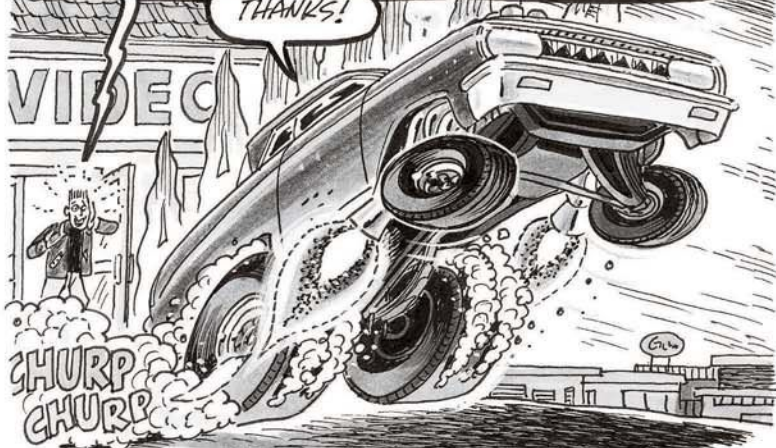
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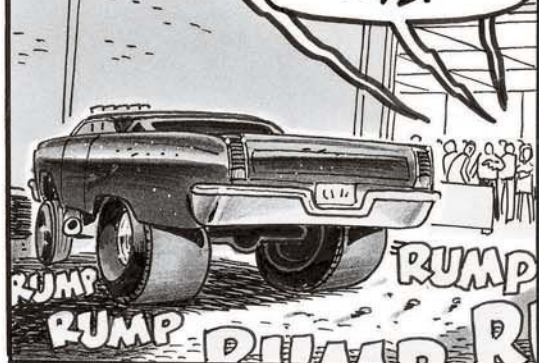
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Having Both Can Pay Off in
Nabbing the Car of Your Dreams

By Christopher Campbell / Photos: John Machaquiero



Everyone has a story of the one that got away. That was the case for Danny and Laura Bouchard when they went after the 1966 Fairlane that Danny had always wanted. Then again, sometimes you have to be persistent and patient to get the car you really want.

Danny and Laura originally tried to purchase this Fairlane during an eBay auction back in June 2007. Though they tried, they lost the auction to a gentleman in Ontario, Canada. Not wanting to give up, Danny passed their contact information to the seller of the Fairlane and asked him to

forward it to the new owner. The seller did so, and about a month later, the new owner called. He asked why Danny was still interested in the car. Danny told him that he had always wanted a 1966 Fairlane and hoped one day, if and when it came up for sale again, he would give him first option to buy it. The gentleman said he understood and appreciated Danny's interest, but said the car was not for sale. Danny was a bit disappointed, but he moved on and purchased a 1963 Thunderbird in March 2008, another eBay find, and restored that vehicle in lieu of the dream Fairlane.



Two years later, out of the blue, Danny received an email from the owner of the Fairlane asking if he was still interested in it. You can imagine Danny's mixture of surprise and excitement. Of course he was, but Danny had that Thunderbird, so he requested a couple of weeks to get his finances in order. In April 2010, Danny took the Thunderbird to the Ford Nationals in Carlisle, Pennsylvania, and sold it within three hours of being in the car corral. He called the owner of the Fairlane right away and told him the deal was done and that he and Laura would drive to Ontario and pick it up. In early

May 2010, almost three years after losing it in the original eBay auction, Danny was sitting behind the wheel of his dream car.

For about the first year, he simply drove the car as it was, enjoying cruising and going to car shows. However, he was pondering some upgrades. In September 2011, he found a Dart Iron Eagle 427 on eBay Motors and watched it go through two auction cycles. The engine would be perfect in the Fairlane, which he and Laura has nicknamed "Franchesca." Danny eventually contacted the seller and made an



offer to purchase it. At first, he rejected the offer, but after a couple weeks, Danny called back with another offer. Patience paid off again when the seller agreed. The deal was done, the engine was shipped from California to Connecticut, and the next phase of the dream became a reality.

With such a powerful engine, Danny and Laura knew that they would have to redo the entire driveline, starting with Baer brakes to keep bursts of speed under control. Behind the 427 went a new Monster AOD transmission, custom driveshaft, 9-inch Currie rear with Eaton TruTrac, and 3.70 gears. In the end, they achieved the dream of having a 1960s muscle car, with the perfect mix of old and new.

Since completing the driveline modifications, Danny and Laura have driven the Fairlane nearly 2,000 miles. They've been to the National Street Rod Association (NSRA) North East show in Burlington, Vermont, the Ford Nationals at Carlisle, Pennsylvania, and the Goodguys National East show in Springfield, Massachusetts. Next up they plan on attending the Fairlane Club of America (FCA) National meet in York, Pennsylvania, the Adirondack Nationals at Lake George, New York, and back to Burlington for the NSRA show. "We love driving our car—no trailers for us," Danny said. "We simply enjoy cruising in our special car; we consider it therapy every time we turn the key and go!"

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TECH NOTES

Who: Danny & Laura Bouchard

What: 1966 Ford Fairlane

Where: Mystic, CT

Engine: The 600hp/548-lb-ft 427ci Windsor is based on a Dart Iron Eagle block machined by Keith Craft Racing and filled with a Scat crank and 6.250 H-beam rods and Mahle forged pistons. Up top are ported AFR 225cc aluminum heads with 2.08/1.60 valves getting air and fuel from a Borla Stacked 8 EFI controlled by Fuel Air Spark Technology (FAST) XFI 2.0. Ignition is via an MSD Pro Billet distributor with a 6AL box. Vintage Motorsports of North Haven, CT, was instrumental in tuning the 427 engine; special thanks to Jay, Brian, and Jeff.

Exhaust: Ford Powertrain Applications' 1.75-inch primary headers with 2.5-inch pipes and Flowmaster 50-series mufflers create beautiful music.

Transmission: Monster Transmission built a stout AOD with a 2,500 stall

converter to handle the 427's power.


Rearend: The Currie 9-inch has an Eaton TruTrac diff, 3.70 gears, and 31-spline Currie axles.

Suspension: It's all stock front and rear, though rebuilt. The steering was upgraded to a Borgeson power-steering conversion box.

Brakes: Baer Track4 4-piston calipers with 13-inch drilled and slotted rotors up front, Baer, 2-piston calipers with 11-inch drilled and slotted rotors in the rear.

Wheels/Tires: American Racing Daytona wheels are fitted with 225/45 and 235/50 Nitto NeoGen tires.

Interior: The interior is perfectly new and perfectly stock, other than the addition of three Stewart Warner Green Line Gauges monitoring oil, water, and volts.

Exterior: The gorgeous color is Acapulco Blue, a 1967 Ford color. The R-code Fairlane style hood is from Crites. 



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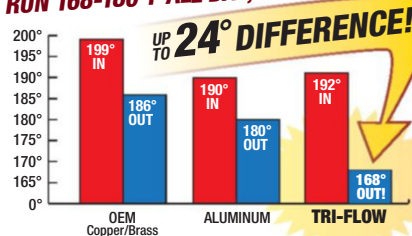
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SPLIT PERSONALITY



Most would agree that any involvement in the car hobby should be fun. Let's face it, if it wasn't fun, would we really call it a hobby? If the enjoyment aspect at some point evaporates, that hobby can become rather unsatisfying, and finding a suitable replacement isn't always a guarantee. For Virginian John Mead, having an enjoyable time went hand in hand with owning and showing his 1968 Camaro.

His Camaro was a real-deal Tuxedo Black RS SS. The RPO L34-optioned car sported a 396ci, 350hp engine mated to an M22 four-speed. It was also a rare, A/C-optioned car. For John, it represented a five-year investment of time and

money in a restoration. "We went to a lot of car shows," he said. "We took that Camaro everywhere, and one of the things I noticed, and I got very bored with, was that everyone had Camaros—and just as many wannabe GTOs that never were [real] GTOs." After many years of wheeling the Camaro on and off of a car trailer, monotony set in. At that point, an individual approached John at a show, asking if his Camaro was for sale. That question was met with a swift "not really!" That answer changed, however, when a generous offer was made: "He made me an offer that I couldn't turn down."

With a big chunk of money in hand, most would be itching

John Mead Restored This 1963 Catalina to do Battle a Quarter-Mile at a Time

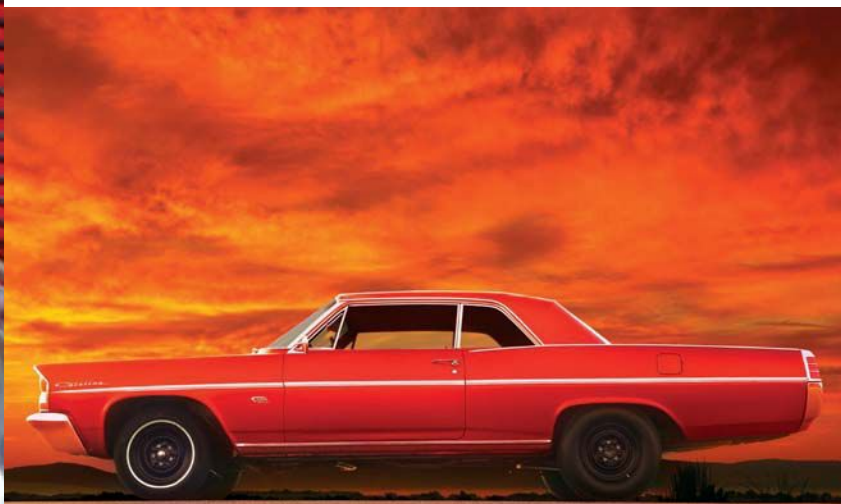
By John Machaqueiro / Photos: John Machaqueiro



to find another project. John explained, "I really wanted to [build] another car, but I wanted to do something different. I didn't want to be hung up in that same old thing again." While surfing some of the online auction sites, he stumbled on the 1963 Catalina you see pictured. "What struck me were the 8-lug wheels and the 421 emblems on the fenders," he said. "The pictures showed the engine compartment with the three two-barrel carburetors and an amazingly well-preserved interior with the four-speed, radio delete, and factory tach. However, rust in the sheetmetal was also evident from the photos."

A phone call to the seller revealed quite a bit of additional

information about the car. Originally delivered to Johnson Pontiac in Clinton, Iowa, the Catalina was now in Michigan, where it had spent part of its life. The original owner's son had moved to Michigan to attend college in 1982 and used it as daily transportation. When he headed back home, he signed the title over to the second owner, who left the car parked in his yard since 1992. John asked the owner to give him a few days to think about the purchase, but the owner emphatically said, "If I don't sell it over the weekend, it's going to the junkyard." John thought, "There is no way in hell that car is going to the junkyard, buddy." He cut a deal that put the Catalina on a car hauler headed to Virginia. As a



bonus with the purchase, John also scored the IDENT-O-PLATE and build manifest signed by Larry Johnson.

The car was complete and driveable, but it didn't take long to figure out that the Michigan and Iowa weather had taken a toll on the body. John asked his friend, Otis Collier, who owns So-Low Street Rods in Troy, Virginia, to help restoring the car. Otis agreed, but was only available to help on Saturdays.

At the shop, the body and frame were separated, and the body was placed on a rotisserie. Media-blasting both the frame and body exposed the hidden sins. The frame was in good condition, but several sections of the body were too far gone. Blasting through two layers of paint uncovered severe rust damage to the rear quarters and wheelhouses. They also found a skim coat of plastic filler on the roof, hood, and trunk. At some point, someone wearing high-heel shoes did a dance on top of the car, damaging it from front to back. All those panels would have to be replaced.

Having good friends with like interests is always a plus when putting a car together. One of John's friends gave him a 1963 Catalina two-door hardtop parts car to aid in his restoration, but his optimism was quickly dashed. When they dug into that car, they found it to be in a similarly poor state.





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So John purchased the rear section of a third Catalina from a salvage yard in Montana, which he was able to use to replace the damaged body panels on his car. Eventually, the completed body was put in primer, then bathed in PPG Marimba Red basecoat/clearcoat paint.

While the body had been a monumental challenge, the interior was the exact opposite. The carpet and headliner were the only two items that John replaced, while the rest of the interior trim, seats, and door panels are original to the car.

Equally original to the Catalina was the drivetrain. The unmolested, numbers-matching, High Output 421 came tucked between the fenders. Though the odometer registered just over 28,000 miles, John suspected the odometer had rolled over at least once, and the state of the engine confirmed it. He took the engine to Dan Lowery at Action Auto Works in Fairmount, Virginia, who punched it out to 427 ci, stuffed a new set of TRW forged flattop 11.5:1 pistons in it, and rebuilt the heads. This ended up being more than just an engine rebuild. "Dan and I got to talking and he said, I have something you

might be able to use. He went in his shed and brought out a rather rare and unique fiberglass Catalina bumper that he had stashed away for 35 years," John said; \$100 was all it cost to bring that piece home.

The rest of the drivetrain was completely rebuilt back to factory stock. The original four-speed was sent to Spraker Racing Enterprises in Mooresville, North Carolina. They rebuilt the gearbox and replaced all the internals with a focus on improving quarter-mile times. The stock rear was redone as well, but the 3.42:1 differential was replaced with a 4.10:1 unit.

Some of these changes were taking place because John had developed a taste for nostalgia drag racing. "When I first started working on the car," John said, "I had no intentions of drag racing it." That changed when he discovered articles in magazines about vintage drag racing and nostalgia events, and began reading up on the Super Duty Pontiacs. "I started thinking, I'm just not that far from drag racing that Pontiac. I have the motor and the transmission. When I found that fiberglass bumper, it further added to my interest."

As the car came together, some things were modified to help it down the quarter-mile. He opted to install stamped steel wheels wrapped in M&H Racemaster Vintage Drag Slicks at the back and whitewalls up front, instead of using the original 8-lug aluminum units that came on the car. The battery was also relocated to the trunk in order to shift weight to the back. He estimates that the weight savings with the fiberglass bumper and stamped steel wheels alone has shed almost 100 pounds of weight off the Catalina.

As mentioned previously, the restoration took place on Saturdays—186 of them, to be exact. After 3½ years of work, it was completed in 2010. While the car was good enough to compete in some shows, John had an attic full of trophies and had lost all ambition to do it again. "I have too much fun when I go to the nostalgia events," he says. "It's not the fastest car there, but it will draw the biggest crowd. This car actually has a split personality. If I put the 8-lug wheels and steel bumper back on it, I can go to a show. Swap them off, and I can go to the dragstrip." He has yet to make that swap, though. ☑

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WTF? (WHERE'S THE FUN?)



EL CAMINOS ARE, ER, ALL HIS LIFE

Who: Matt Orr

What: 1966 El Camino

Where: Ruston, LA

Why: "I've had El Caminos all of my life, but let's don't analyze what that might say about me!" This is Matt's daily driver, sporting a 350 with RHS heads, a small Comp cam, a 700-R4 trans, 4.10 gears, a 10-bolt rearend. He still manages 18 mpg. "And rumor around the house is that it might have a big-block in its future!"



WHAT HAPPENS IN VEGAS—IS THESE CARS

Who: Tom and Diane Grayson

What: 1968 Chevy Nova and 1970 Chevy Vega Wagon Gasser

Where: Las Vegas, NV

Why: "Tom wrenches and Diane does the upholstery." Now you have the backstory to their rides. The Nova has a 383 SBC with dual Holleys on a tunnel-ram intake, Hays clutch, TKO 600

five-speed, Ford 9-inch, 4:11 posi, 2-inch drop spindles up front, and a rear subframe welded and mini-tubbed with an eight-point cage. The Vega's 331ci mouse engine has twin Holleys on a tunnel-ram intake, a turbo 350 tranny, Ford 9-inch, and one-piece fiberglass front end that tilts to show the custom tube chassis with 10-point cage.

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IN THE NEWS



TEAMVALVOLINE.COM FOR RACING JUNKIES

Valvoline has launched TeamValvoline.com, a site dedicated to content for racers and racing fans. There will also be online activities, ways to earn points for special deals, the ability to apply for Valvoline sponsorship through an online submission form, and more.

GOODYEAR TIRE THAT CHARGES ELECTRIC VEHICLES?

Goodyear Tire & Rubber Co. created a concept tire called BHO3 that's designed to charge an electric car's battery. The idea behind it is that the heat generated from a rolling tire would convert to electrical energy.



→SEND STUFF TO CAR CRAFT!

We need more pictures of Burnouts, please. While you're at it, send any of your compliments, complaints, random musings, or pet pictures to us. Here's how:

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disclaimer: If you can't write a complete sentence, don't worry, we will make your work comprehensible. That includes making up stuff we thought you meant.

MOST POPULAR FORD MUSTANG COLORS

Ford did some paper shuffling and discovered what seems to be the most popular colors for the new Mustang. White is the highest-ranker in the U.S., while in China it's Race Red. It's a tie in Europe: Race Red and Absolute Black.



BLOWN-UP PARTS



"The 8 3/4 from my 1972 Dart at 3,500 pounds. It held up through 30 years of foot-brake racing, only to break the main caps. I was able to salvage the spool, and the case can be reused with new caps."

—Eddie Weaver, via email

→ LETTERS



NAME OUR 1980 OLDS

In your June 2015 issue, John McGann wrote you're open to readers' name suggestions for the 1980 Oldsmobile Cutlass bracket car. In a rare moment of neuron alignment, what came to mind for me was, simply, Cut-loose, Cutloose, 80 Cut Loose, or something along those lines. If you go for it, kick the idea upstairs and let your creativity team work out the details. It's hard to figure the name hasn't been used in the past, but I've never seen it anywhere. Good luck with your less-than-11-second goal. Whoa, it happened again—OK, my second name idea is Less than Eleven. That's enough hard work for me for one day. Time to take the rest of the day off! Keep up the great work and "keep 'em rolling!"

—Geoff Rolland, via email

Thanks, Geoff! Here are a few others we've received: Blue Bayou, Blue Thunder, Nacho Daddy's Olds, Twisted Sister (because with a big-block engine, it will have frame-twisting torque), Olds School, The Blue Bomb, The Hamm's [beer] Special, Corrodesmobile, Blue Moon, and Gee Whiz.

Believe it or not, **Car Craft** has a second intern! Taylor Kempkes is a senior at Long Beach State, drives a



1999 BMW M3, and used to play volleyball. He claims that he's selling the M3 for a 1960s muscle car soon. We certainly hope so!

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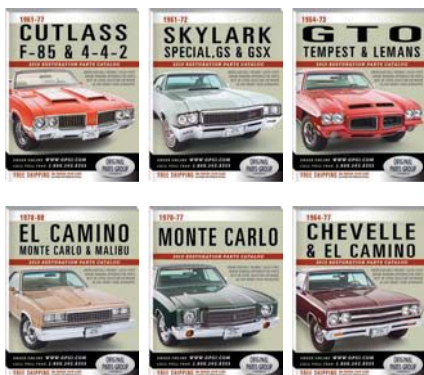
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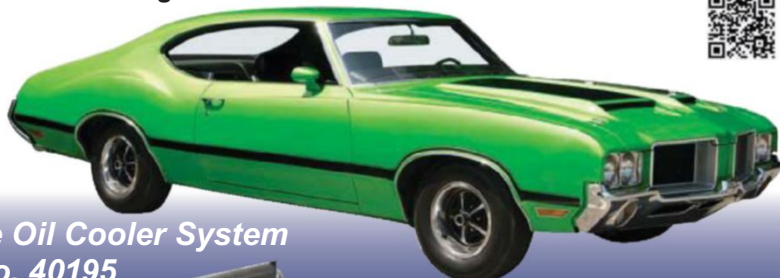
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REAR VIEW



ULTRA TRUCK SHOW ROD

In the late-1950s and early 1960s, **Car Craft** represented all manner of, well, car crafting. Whether a custom for the show circuit, a performance car for racing on dirt, or the oval or a dragstrip, **CC** was the catch-all magazine with all the tech. In 1964, automotive restylist Darryl Starbird took a Chevy 1-ton pickup cab, placed it on a 1955 Chevy frame, and turned it into the Ultra Truck show rod. A flip-top semi-bubble rises to expose the pleated white Naugahyde upholstery within. A Buick nailhead sits in the engine compartment sporting what might be considered an early shaker-type hoodcoop. Starbird finished the Ultra in coats of "Essence of Iced Tangerine." The Ultra Truck was featured in a two-page spread in the September 1964 issue of **Car Craft**. Monogram models released a nicely detailed plastic model kit of the Ultra Truck in 1966, dubbing it Orange Hauler.

By Thomas Voehringer / Photo: Darryl Starbird

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